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Productivity trends in the Canadian automotive industry.

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PRODUCTIVITY TRENDS IN THE CANADIAN AUTOMOTIVE INDUSTRY

By

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ABSTRACT

The objective of this study is to determine productivity trends in the Canadian Automotive Macroeconomic sector since the signing and implementation of the Canada - United States Automotive Products Trade Agreement of 1965. The study encompasses all automotive manufacturers whose products are identified by the Standard Industrial Classification Codes #323 and #325.

Total Factors productivity defines a relationship between total production output and all the associated resource inputs expressed in real terms and a ratio form in a sequence of compared periods of the total production macroeconomic sectoral system.

The present study utilizes empirical data, the Integrated Systems Concept of measuring productivity and multiple regression analysis. It provides productivity trend analysis for the intervening decade, (1964-1973).

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CHAPTER I
INTRODUCTION

A. An Overview of the Canadian Automotive Industry

The establishment of the Canadian automotive industry began in Windsor, Ontario, in 1904 with the manual assembly of 117 Ford vehicles during the first year of its operation.[47] Many attempts were made by Canadians to produce automobiles and failed. It was in 1908, when Canada's foremost individual in the automotive industry, young "Sam" McLaughlin, first built a motor vehicle. With the arrangement to purchase Buick engines, the McLaughlin Motor Car Company was established to build the rest of the automobile in Oshawa, Ontario.

Canadian government of the day provided the tariff protection of 35 percent to its infant automotive industry; however, it was not enough. [20] All automobile ventures that survived in Canada were allied to successful United States motor vehicle companies. The master mechanics of Detroit had developed the techniques of mass production for mass consumption which were necessary to make the automobile a practical, commercial, and profitable product.

Canadian automotive industry leaders always had basic agreement with the federal government in power that the industry must develop economic production of motor vehicles in Canada as efficient as the size of the market would permit. To effectively develop the industry in Canada, the Motor Vehicle Manufacturers' Association made a number of suggestions to the tariff board: (1) to simplify the tariff regulations to be subordinated to the prime need for adequate and equitable protection by increasing the intermediate tariff and imposing excise tax; (2) to establish in-plant content base, whereby it would be necessary to attain a minimum of Canadian content produced in each plant; (3) to lower duties on production machinery of a class and kind not made in Canada as a positive inducement to manufacture automotive parts in Canada.[20] The Association made further suggestions, all of which were designed to reduce the cost of vehicle production in Canada and to enhance competitive position of the automotive industry in relation to the United States and European imported vehicles.

The European and United States motor vehicle import situation became considerably aggravated in Canada in the fifties due to the stagnant position of the domestic automotive industry during a period of growth in the Canadian market for automotive products. This stagnant position became sufficiently important for the federal government to appoint the distinguished Canadian economist and scholar, Prof. Vincent W. Bladen, as the one-man Royal Commission to inquire into and report upon the situation of prospects for the industries in Canada manufacturing motor vehicles and automotive parts.[9]

The Royal Commission conducted its hearings with all parties concerned which culminated in the report submitted to the Canadian government in April of 1961.[9] In the report, Prof. V. W. Bladen expressed his diagnosis on the basis of voluminous submissions of all concerned and prescribed his recommendations for the implementation.

The most important characteristics of the Canadian automotive industry has been its domination by the same industry in the United States. To implement any or all of Prof. V. W. Bladen's recommendations, the Canadian government had to commence negotiations with the United States government and the automotive corporations concerned. Negotiations between the two federal governments lasted about four years and culminated in the reaching of the Canada - United States Automotive Products Trade Agreement of 1965, which was signed by the two governments on January 16, 1965.[9]

The Canadian junior partnership in the North American automotive market achieved a most significant milestone in 1967 as the original terms of the 1965 agreement were almost fulfilled. During that calendar year, the Canadian industry reached new all-time records in the production output, facilities expansion, productivity growth, sales, employment, and payroll.

B. The Objective of the Study

The objective of this study is to determine productivity trends in the Canadian automotive industry by means of productivity measurements and, at the same time, evaluate the extent of technological and labour contributions to the productivity growth in the subject industrial manufacturing sector since the signing and implementation of the Canada - United States Automotive Products Trade Agreement of 1965.

This study encompasses members of the Motor Vehicle Manufacturers' Association[75], the Motor Vehicle Parts and Accessories Manufacturers' Association[76] of Canada, and all other automotive manufacturers whose products are identified under the Standard Industrial Classification (SIC) Code #325 and #323, respectively.

C. The Problem Statement

The Canadian automotive industry has implemented the most modern manufacturing, assembly and quality control techniques thus upholding manufacturing management's concept that the high degree of work specialization with a drastically increased volume of production leads to a definite productivity growth. As a result of this management philosophy, automotive industry corporations in Canada have limited their production to a minimal number of parts per manufacturing plant and to only a few car or truck assembly lines per each assembly plant. Sophisticated production, assembly automation, and automated material handling facilities have been installed to enormously improve productive capabilities (i.e. 110 engines per hour versus 16 engines per hour), reducing the cost of vehicle production to a minimum; therefore, the Canadian automotive industry merits to be studied to provide productivity trend analysis for the intervening decade.

D. Definition of the Problem

The term "productivity" defines a relationship, expressed in real terms and a ratio form, between production outputs and the associated resource inputs in a sequence of compared periods of the total production system. This relationship establishes, at least, rough measure of the impact on the production process of the investments and other variables that advance knowledge, improve technology and organization, and otherwise enhance the productive efficiency of the factors of production.

E. Importance of this Study

Productivity has remained highly resistant to the attempts of students of the subject to provide universally acceptable methods of measurements. The methods of measurement which were recommended for use in productivity, such as total costs per unit of output, worker effort and labour productivity, have been proven inadequate. They do not allow for the complex realities of productivity growth. Reliance on costs per unit of output provides for no satisfactory indication of the level of performance of the production system. Labour productivity, measured in terms of labour time, or work measurement data for labour efforts, labour costs, is too narrow a measure of one input to be meaningfully representative of total productivity.

If productivity is to be successfully measured, the productivity of all resources being used in combination of the production system must be taken into account. To meet these requirements, partial and total factor productivity methods which take into consideration the complexity of the total production system, are utilized in this study.

The productivity trend analysis and results obtained from it will contribute to a better understanding of the Canadian automotive industrial sector performance, and provide an improved base for comprehending the importance of productivity growth and its measurements.

To further improve the reliability of the productivity trend analysis, a multiple regression model will be used to compute productivity indexes of both sub-sectors of the automotive industry sector as elaborated on in Chapters III and V.

II REVIEW OF LITERATURE

Factors affecting the productivity growth are so interrelated that determining the separate effect of each one is an impossible task. Changes in productivity can be attributed to factors which vary according to whether the movements are short-term or long-term. Therefore, in this review each author makes his unique contribution in understanding and interpreting concepts of productivity.

In his analysis of the trend of national productivity, Solomon Fabricant[24] stated that the trend rate of increase in output per man-hour in the economy at large was stated to be 3.2 percent per annum during 1958-63. The rate in productivity increase should always be specified in the period from which it was derived. In his elaboration on greater efficiency in the use of labour and capital to improve increased rate of productivity, Fabricant states that of the three sources of increased output per man-hour -- better quality of labour, more tangible capital, and greater efficiency in the use of labour and tangible capital -- it is the last that bulks the largest.

Fabricant strongly concurs that the technological advances has been unusually rapid in our generation. Growth of knowledge and of productivity is a cummulative process that feeds on itself. The knowledge, trained people, and equipment needed to devise new technologies became available in greater supply to influence the increased rate of productivity in the economy at large, but automotive industry in particular.

In his formula for productivity, Faraday [26] equates efficiency with productivity where a prescribed output is created solely by the input of man-power, materials and capital equipment. Faraday further elaborates on a measure of productivity where he assumes that "productivity" is the ratio of output to input. In this case he states that to obtain a measure of productivity is to quantify the four constituents of the formula (output and manpower, material and capital equipment as an input). However, his further admission in this regard is that the calculation of productivity has long been a field of controversy.

Productivity, at times, is expressed in terms of "the value added concept" where a sales volume or price of an item produced is needed.

Faraday is of the opinion that there is a direct relationship between national productiviy and a country's standard of living. Standard of living depends on the total value of goods and services produced in a country and on the number of people living there. The author considers two factors - total national income and total population - and this is his basis of measuring the standard of living, expressing it in terms of the average income per head of the population.

Gossling[30] has developed the concept of a sub-system where he makes an attempt to abstract from the difficulties pertaining to the interdependence of separate activities in an industrial system. The analysis of a system into sub-systems is a novel approach to the theory of the industry and of the commodity within the economy. In his application of sub-systematic analysis to a firm, Gossling uses a set of matrices and rather elaborate indices to obtain desired results of a firm's activities, such as inputs, outputs, and the measure of productivity.

Salter[55] considers three questions which are preliminary to the analysis of the effects of the process on best-practice productivity: (a) the relationship between technical knowledge and techniques of production; (b) the nature of the interaction between economic choice and technical restraints; and (c) the controversial question of units of measurement for factors of production. To express the concept of production function in concrete terms, and to relate it to the productivity factors of production, units of measurement must be specified for each factor. In a simple case where labour and capital are the only factors of production, these restraints are described by the function: $O = f(N, I, 1)$,

Where O = output per annum
N = man-hours per annum
I = initial investment at constant prices, and
1 = the life of this investment

Such a production function describes each possible technique in terms of labour force and initial investment required to produce a flow of output extending over periods of time.

Siegel[36] in his rather extensive presentation "On the Design of Consistent Output and Input Indexes for Productivity Measurement" elaborates on the subject of multifactor productivity. In his opinion, it is much easier to write consistent formulas for multifactor productivity than actually to measure non-labour factor inputs in suitable characteristic units. To assure that the productivity formulas are internal means of relatives, the cancellation rule is involved. He, specifically, proposes to employ a concept of net output that is identical in scope with factor input. In this case, if the inputs refer to labour and capital, the net output concept should ideally be restricted to the value added by these factors.

Siegel provides the verbal indentity, Multifactor Input = Net Output x Unit Factor Requirements, leads to at least two kinds of consistent formulas. In one case, according to Siegel, the net output measure is really a Paasche or Laspeyres aggregative index of gross quantities with "nettifying" unit-value-added weights. Since the input concept corresponds to net output in scope, valuation at cost permits one to write a Paasche or Laspeyres input index that yields a productivity measure containing only weighted aggregates. In Siegel's opinion, this productivity measure may be re-written as a weighted mean of relatives.

Richard and Nancy Ruggles[36] in their presentation of "Concepts of Real Capital Stocks and Services" have made very meaningful contributions to the measurement of productivity as one of the major purposes for which real capital stocks and services data are developed. The very concept of productivity, in their opinion, implies that the contributions to output that a factor makes can differ for reasons other than differences in the quantity of that factor.

The two authors are of the opinion that the measurement of output in real terms reqbires a determination of the quantity of capital produced. Capital formation not only provides for future input into the corporate system, but it is also a major component of gross national product and national income.

Ruggles approached the quantity of capital as a concept for productivity measurement with detailed analysis of the subject matter. The concept involved in measuring the efficiency of capital as a factor of production can be traced back to the same notions underlying the theory of production function. In their analysis, the two authors have shown numerous examples to prove their point.

Kendrick[38] in his monumental study provides the background for an analysis of the role of productivity in aggregate economic growth and a standard for comparison of productivity changes in the individual industries of the economy. He attaches special interest to over-all productivity indexes as the best available measures of net changes in the productive efficiency of the entire national economy. In effect, it is the author's strongly supported thesis that the index of productivity in the private domestic economy is a weighted average of productivity indexes for the various industrial sectors.

Kendrick undertook to provide macroeconomic study and he uses the national productivity estimates for the analysis of aggregate economic growth comparing long-period productivity trends in the private domestic and the total national economies. He describes the long-term growth of total factor productivity and the partial productivity ratios in terms of average annual rates of change between the segments of the long period.

Kendrick looks not only at the aggregates for the macroeconomic analysis but he looks at the diverse productivity movements in the various sectors of industries. Not only do various sectors of industries provide productivity indexes, but they reveal the sources of national productivity advance by industry or origin and relative changes in productivity by industry can be related to changes in other variables of input. The author also provides sectoral macroeconomic analysis in various industrial groupings and, therefore, he gives very generous descriptions of the estimates of total factor productivity and the partial productivity ratios for major segments of the economy.

Lithwick, Post and Rymes[11] attempt to examine production relationships in Canadian manufacturing industry from several perspectives. The three authors present their study in three sections:

(a) Capital inputs and investment decisions, thus employing three models in the analysis of investment behavior.

(b) Total measured factor productivity is examined at a disaggregated level within the Canadian manufacturing sector. The main set of their estimates deals with thirteen combined major groups.

The estimates reveal (1) the expected cyclical sensitivity of total measured factor productivity; (2) substantial inter-major group variations in measured productivity advance; (3) considerable sensitivity with respect to assumptions about the average economic lives of fixed capital goods. To prepare cyclical sensitivity to their estimates, the authors compiled a table and a chart for each major manufacturing group. Collected data suggest either advances or declines in total measured factor productivity.

(c) The final section surveys Cobb-Douglas type functions which have been applied to the major sectors of the total economy. The authors suggest that while manufacturing growth performance was not spectacular in the postwar period, it had contributed substantially to the growth of aggregate productivity.

The three authors have presented a rather lengthy statistical appendix, which includes most of the data developed for their study. Finally, they have added a technical appendix which gives the theoretical arguments that underlie the procedure.

CHAPTER III

REGRESSION ANALYSIS

A. Simple Linear Regression Model

Regression analysis is a statistical tool which utilizes the relation between two or more quantitative variables so that one variable can be predicted from the other, or others. For example, if one knows the relation between advertising expenditures and sales, one can predict sales of cars by means of regression analysis once the level of advertising expenditure has been set. Regression analysis can be utilized when a single independent variable is used for predicting the dependent variable of a particular interest.

There are two relations between variables that can be considered here: A functional relation and a statistical relation. A functional relation between two variables, is expressed by a mathematical formula. If X is the independent variable, a functional relation is of the form:

$$Y = f(X)$$

If a particular value of X is given, the function f indicates the corresponding value of Y. This functional relation is expressed by the equation: $Y = bX$

B. Multiple Regression Model

Multiple regression analysis is a method of taking into account simultaneously the relationship between all the variables when two or more independent variables are to be used in making estimates of the dependent variable Y_i. The use of two or more independent variables is an extension of the basic principles in two-variable regression analysis.

First, it is necessary to determine the first-order model with two independent variables. Next, a measure of the accuracy of the estimates from this model must be computed.

The model for a multiple regression analysis with two independent variables is written:

(1). $Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \varepsilon_i$

This model is also known as a first-order model with two independent variables. As explained previously, a first-order model is linear in the parameters and linear in the independent variables. Y_i denotes the dependent variable in the ith trial, and X_{i1} and X_{i2} are respective values of the two independent variables in the ith trial. The parameters of the model are β_0, β_1 and β_2, and the error term is ε_i.

Assuming that $E(\varepsilon_i) = 0$, the regression function for the model (1) is :

(2). $E(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2$ [49].

In a simple linear regression function $E(Y) = \beta_0 + \beta_1 X$ is a line, in this regression function (2) it is a plane. It is, at times, called a regression surface.

The model for a multiple regression analysis with (p-1) independent variables $X_1 \ldots\ldots X_{p-1}$ is written as follows:

$$(3).\quad Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_{p-1} X_{i,p-1} + \varepsilon_i$$

Assuming that $E(\varepsilon_i) \equiv 0$, the dependent function for the model (3) is written as follows:

$$(4).\quad E(Y) = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_{p-1} X_{i,p-1}$$

This is no longer a simple linear function,it's a dependent variable function known as a hyperplane.

The general linear regression model, with normal error terms, is written as follows [49]:

$$(5).\quad Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_{p-1} X_{i,p-1} + \varepsilon_i$$

Where:

$\beta_0, \beta_1, \ldots, \beta_{p-1}$ are parameters

$X_{i1}, \ldots, X_{i,p-1}$ are independent variables

ε_i are independent $N(0,\sigma^2)$

p-1 are different independent variables

$i=1,\ldots,n$

Let $X_{i0} \equiv 1$, Model (5) can be written as follows:

$$(5a).\quad Y_i = \beta_0 X_{io} + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_{p-1} X_{i,p-1} + \varepsilon_i$$

Where: $X_{io} \equiv 1$

Since $E(\varepsilon_i) = 0$, the dependent variable function for model (5) is:

$$(6).\quad E(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_{p-1} X_{p-1}$$

In the general linear model for every combination of fixed X's there will be a distribution of Y's. Each distribotion will have a mean, and a standard deviation with the assumption that these distributions are normal and that the standard deviations are equal.

CHAPTER IV

MAJOR FACTORS AND CONCEPTS OF PRODUCTIVITY

The operational concept of productivity can be separated into two main categories consisting of total factors productivity and partial factor productivity. Total factors productivity relates total output to a weighted aggregate of all associated inputs. It is a very broad concept which is influenced by a wide range of factors and the interrelationships among them. Partial factor productivity relates output to either a combination of several input factors such as capital, labour and cost of materials, or to a single input such as capital.

In this chapter, a series of synthesized major factors and concepts contributing to productivity growth are described and/or defined in the following manner:

Major Factors Contributing to Productivity Growth

A. Corporate Management

The most important characteristic of the Canadian motor vehicle industry is its dominance by that industry in the United States. The motor vehicle manufacturing companies are owned and controlled by parent organizations in the United States.[9] Top executive officers, whether American citizens or Canadian citizens, are appointed for certain periods of time by their respective corporate executives in Detroit. Canadian motor vehicle manufacturing corporations are managed, with a few isolated exceptions, in the same manner and style and by the same philosophy as their parent corporations in Detroit.

Contemplating new policy measures, the government of Canada informed the motor vehicle manufacturing industry that it intended to take action to improve the trade imbalance with the United States by reducing imports or increasing exports by whatever means were available and necessary. The motor vehicle industry was to be its first and most important target.[20] The corporate executives of the automotive manufacturing companies of Canada immediately began short- and long-range planning and developing programmes to comply with the government of Canada policy in reducing trade imbalance.

Short- and long-range planning became of paramount importance to top corporate executives. Planned change was essential at the time and productivity opportunities were identified. Executives, therefore, were concerned with how well automotive corporations achieve their objectives and the total resources required to achieve them. Productivity became an integrated and continuous part of all functions of planning and policy implementation,and a concern with every function, each act and activity, and all resources.[15] Corporate managements' planning, itself, became highly productive as it has increased the productivity of other functions and activities during and after the period of the implementation of the Canada - United States Automotive Products Trade Agreement of 1965.

B. Capital Investment

Growth in capital per man-hour has been an important factor in productivity improvement, since more and better equipment allows a worker to perform his job more effectively.[46] Productivity is more likely to increase rapidly in an automotive corporation where this ratio is high than in a corporation where it is low.

Capital investment has made very important contributions to the growth in output per man-hour with the signing and implementation of the Automotive Products Trade Agreement of 1965 in Canada. Most researchers [20] have concluded that total output per man-hour has increased in large part because the amount of capital supporting each worker has increased substantially in the Canadian automotive plants.

The role of capital investment is outlined by measures in the implementation stages of the Agreement during 1965 through 1968. The motor vehicle manufacturers alone invested $533 million in new modern assembly and parts manufacturing facilities, increasing their employment by 5,150 persons. Their purchase of automotive parts increased by $510 million over 1964 level (base year). Vehicle assembly capacity was increased by over 50 per cent to over one million units a year.[20] Further importance of capital investment in the Canadian automotive industry can be emphasized by the following achievements: 69 new plants and 136 plant expansions, a 27.5 per cent increase in production, a 51 per cent increase in the automotive parts and accesories production, a 16 per cent increase in employment, a 94 per cent increase in exports, only a 33 per cent increase in imports, and price reductions on the average factory wholesale price differential from about 8 per cent to somewhere between 3 to 5 per cent on basic automobiles.[20]

C. Economies of Scale

The Canadian Automotive Industry operations have expanded and the high degree of modernization was achieved within this macroeconomic sector, therefore, certain economies of scale have been realized in accordance with the previous plans. After optimally adjusting all imputs, the unit cost of production has been reduced by increasing the size of plants and a degree of specialization in them.

Proficiency is gained by concentration of effort. The advantages of division and specialization of labour have long been known to both industrial management and economists. [40] Larger plants with larger work forces employed by the automotive corporations permit, and actually require, each worker to specialize in one job, gaining proficiency and obviating time-consuming interchanges of location, tools and equipment. Proficiency, naturally, contributes to a corresponding reduction in the unit cost of automotive production.

Technological factors constitute a second force contributing to economies of scale. For larger outputs and scales of plant for mass production, technological methods are used to affect reduction in per unit costs.[40]

Another technological element in the automotive industry is the fact that the cost of purchasing and installing larger machines, particularly multi-station transfer lines, is usually proportionally less expensive than the cost of smaller, individually operated machines. A final technological element is perhaps the most pronounced: as the scale of operation expands in each automotive corporation in Canada there is usually a qualitative, as well as quantitative, change in machinery, equipment and fixed assets.[46]

Expansion of scale of the automotive manufacturing and assembly facilities with the signing and implementation of the Canada - United States Agreement of 1965 encouraged and required by Canadian law the introduction of the most modern manufacturing and assembly technology to gear for the North American automotive products market. All these innovations and scales of production have enormously reduced the unit cost of products thus increasing productivity growth.

There are financial reasons for economies of scale. Large-scale purchasing of raw and processed materials enables a corporate buyer to obtain more favourable prices (quantity discounts). The same is true of advertising and financing of large-scale automotive corporations are normally easier for and less expensive than for smaller corporations. Large North American corporations with branches in Canada have easy access to organized security markets, so they place their bonds and stocks on a more favourable term. Bank loans usually come easier and at lower interest rates to well-known automotive corporate giants.

In the final analysis, economies of scale of division and specialization of labour, technological, and financial factors[40] influence productivity growth very substantially.

D. Technical Factors

All factors except human performance factors which are contributing to productive efficiency are considered to be technical ones. In the automotive industry, particularly manufacturing phase of it, operations are capital intensive, and the most important factor influencing productivity is the technological development. On the other hand, in the assembly operations, the degree of technology may have lesser effect on productivity, and human performance may be the major determinant. Some of the more important technical factors have been identified in the automotive industry and are listed below:

A. Plant:

1. Size
2. Capacity (production output per day).
3. Efficiency (percentage of capacity utilized).
4. Design and age of production machines and equipment.
5. Layout of plant and jobs, workflows and methods.
6. Degree of integration of the production processes.
7. Length of production runs.

B. Product (automobiles and trucks):

1. Design
2. Quality
3. Product mix and degree of specialization
4. Competitive advantages (power out put vs.power plant. weight,etc.)
5. Immediate availability of spare parts to service original equipment.

C. Raw Materials:

1. Quality
2. Continuity of supply
3. Scarcity of supply

D. Power Use:

1. Fuel (oil, natural gas, gasoline, diesel oil, liquefied petroleum gases, coal, etc.)
2. Electricity purchased

All of these technical factors have a direct relationship to productive efficiency and can also exert an influence on the measurement of partial factors productivity.

E. <u>HUMAN FACTORS</u>

The automotive industry sector of the Canadian economy endeavours to provide more humanized working conditions constantly planning improvements in job performance, job satisfaction, productivity, and, at the same time, reduce occupational hazards.

A discussion of job performance can be simplified by identifying four major variables that influence employees' job performance and productivity: work environment factors, role perceptions, abilities and skills, and motivation.

1. Work Environment Factors

A great number of factors can be identified with and fit into the category of work environment factors such as working conditions, co-workers, corporate policies, rate of pay, generocity of incentive plans, strictness of discipline, etc. Line supervisors and managers directly influence some of these factors by providing employees with work assignment and/or rotational reassignment, meaningful performance and creating friendly work atmosphere in the departments for which they are responsible[1]. These various factors influence the capacity of employees to effectively utilize their abilities and skills on the job.

The utilization, usefulness of employees abilities and skills and motivation to efficiently perform a job depends to a great degree on the management's capability to schedule necessary production machines, equipment, materials, needed supporting services in case of breakdown, and tactful and honest appreciation for good productive efficiency. Motivation, at times, is adversely affected by the continued absence of meaningful job assignments. If such shortages persist and cause employees to be unable to meaningfully perform, they may soon begin to wonder about their role perception at a work place. Thus, work environment factors influence what employees can do (ability and skill), how much effort they must exert doing it (motivation), and their understanding of what it is they are expected to do (role perception) [28].

Major work environment factors that have a direct or indirect influence on individual employee's job performance and productivity may be identified as follows: task design, working conditions, production and assembly machines, production and non-productive materials, tools equipment, performance goals, organization structure, time, types of supervision and management, work group of immediate co-workers, corporate policies, etc. [1]. In turn, these factors influence in various degrees employees' abilities and skills, role perception and motivation.

2. Role Perception

Role perception is identified as one of the four variables affecting job performance and productivity. It may be defined as the individual employees' imagination of his work responsibility and the kind of effort he imagines is needed to fulfill his work assignment. However, each employee has his own, vastly different concept of a role perception [1]. It is highly desirable from the point of view an individual employee and the corporation that each employee has a clear and accurate understanding of his role perception.

If an employee in the automotive industry perceives that his job performance is primarily evaluated on the basis of the quality of output, he is spending a great deal of time and effort to produce high quality product. However, he may find out to his dismay that his superiors expected of him high quality and quantity output then his performance is being evaluated in these terms, and, therefore, he is appraised as an inferior or unsatisfactory job performer.

In the large automotive industry corporations, role perceptions are learned on the job and instructed by the industrial relations departments, personnel departments, and the line supervisory personnel so that there is no misunderstanding or what is expected of all employees.

3. Abilities and Skills

Individual differences partially account for the differences in job performance between employees. An individual's capacity to perform is determined by factors such as physical size and body type, manual dexterity, verbal and mathematical skills, and other genetically determined and learned individual characteristics.[61]

Abilities are characteristics of individuals. A great number of individual characteristics are learned during childhood and adolescence. Employees already have some ability characteristics when they begin to work in the industry.[44]

Skills are usually identified with the proficiency on specific assignments. [61] An employee may have the manual dexterity ability but does not know how to operate a production machine or a machine tool because he has never learned how to do it, or might have never had a chance to see one. There is a definite relationship between abilities and skills. Individuals who possess certain basic abilities are expected to be able to learn associated skills quicker.

A great number of operations performed in the automotive industry are paced by the individuals doing work. It becomes obvious that individual abilities and skills are basic to pace and job performance. Deficiencies in skills simply and clearly prevent an increase in performance and productivity, even when the desire and pace are present.[34] An individual employee may be well motivated to be productive, but he may not be able to produce effectively because of his undeveloped skills. A zesty pace of operations without a high degree of skill means quality defects in large quantities.

The abilities and skills of individual employees are relatively stable and they are not affected by work environment factors. However, abilities and skills can be changed by means of employee selection, training and/or re-training and development as a long run measure. Abilities and skills are closely related to motivation and all variables have a definite influence on job performance and productivity.[34]

4. Motivation

Motivation is the fourth major variable that determines an individual's job performance and productivity. Motivation process may be described as the mechanism which gets the individual employee from the motivated state to some specific and directed form of behavior that produces positive results in job performance and productivity.[28]

Factors that motivate job performance are numerous, however, the most important one is being identified as a motive. A motive may be defined as an inner state that activates, directs, sustains and stops behavior toward goals.[28] The study of motives is primarily concerned with what it is inside a person that causes the individual to engage in goal-directed behavior. An individual's motives are inferred from observations of his behavior and/or job performance.[42]

Pertinent to this section of the study are the two very important motives: the achievement motive and the money motive. They are discussed here because of their prominent role in job behavior.

a) The Achievement Motive

The most prominent motivator of an individual job performer in the automotive industry is the desire for achievement.[28] The achievement motive is an inner state that activates and directs behavior toward goals and is considered to be a relatively stable disposition, or behavioral tendency, to strive for an achievement or a social success.

Self-motivated achievers possess the following three major characteristics: [35]

1.) Setting their own goals.
2.) Setting goals that are moderately difficult to achieve.
3.) Setting means by which frequent and concrete feedback of performance is obtained.

b) The Money Motive

Employees - hourly rated and salaried - supervisors, managers, and executives are motivated to earn more money or aggregate more wealth by various means.

Money is very important factor because all the necessities of life may be acquired by spending it. Money is very important to some people; it is of some importance to almost everyone.

The role of money is automotive corporations is not all-important to a large segment of work population. For the same segment of employees, money is not the only variable that motivates their behavior to increase job performance and productivity. [28] If money is to motivate productive output, it must be related to that particular job performance.

Money is considered in the automotive industry as a motive - an inner state that activates and directs individual behavior. For employees with high achievement motivation, money serves as a definite indicator to them about their worth to an employing enterprise. High achievers expect to be paid well because they value their services highly. [28] The incentive value of money is more effective in people with low need for achievement.

High achievers do not need money to motivate them to work harder; they are already motivated and are working hard.

3. Other Motives

Several other motives [28] that are important in understanding of motivation in the automotive industry sector need be briefly highlighted in the following manner:

The affiliation motive - the desire to belong to a group or groups of people regardless of any gain achieved by it. The number of groups to which an individual belongs is an indicator of his need and/or craving for such an affiliation.

The competence motive - an individual's concern with balance of successes and failures in his work experience within the industrial corporation. The competence motive reaches its plateau where the individual seldom achieves more than heexpects for various reasons.

The power motive - an important motive with which effective leaders are supposed to be endowed.

The adequacy motive - the basic need of an individual is a feeling of adequacy. A great striving force by which individuals continually seek to make themselves ever more prepared to cope with daily life and work situations.

The inherently human process of being preoccupied with a goal setting in the work situations is a way of life in the industrial society in which an employee can find out who he is, his worth to an employer, and his potential for personal and professional growth. The motivation to work is a basic ingredient in human existence, and through it the employee satisfies personal needs as he achieves personal goals.[35]

The motivation needs for growth and achievement are a part of almost everyone's psychological make-up.

Motivation needs are the factors that can produce effective job performance and productivity because most of them are satisfied through work itself. Once an individual committed himself to organizational objectives, his potential is tremendous - provided his own goals and those of the company have been allowed to influence each other. Motivation-seeking individuals in the automotive industry go to great lengths to reach personal goals with relatively high regard for effective job performance and productivity. [62]

The relationship between need satisfaction and motivation, employee performance and technology, and productivity has been definitely established. Productivity depends on the two factors employee performance and technology.[34] In turn, employee performance depends on motivation and ability and skill of the employee. An individual employee's high degree of motivation alone does not automatically render high degree of productivity if his ability is not suited for the calling and his skills were never properly developed to perform a certain job. However, if the motivation, ability and skills are at their highest level of adaptation but the machinery and equipment are of inferior capacity to produce quantity and quality of a subject product then it is very unlikely that a productivity increase will materialize.

F. Research and Development

Technological innovations in methods of production and new products have been the main source of increased productivity and hence in the increase of the capital growth of the automotive industry in Canada. These gains have occured because improved production processes reduced real unit costs while new products provided greater performance capabilities and, therefore, more real output. Organized research and development based on applied science has become an important source of technological change and productivity growth [65].

Contribution of research and development to productivity growth can be analyzed in the conceptual framework of capital and labour inputs. The question may arise here to what extent research and development expenditures in a given automotive corporation contribute to a productivity increase. The rate of growth of research and development capital investment in different automotive corporations cannot be measured in any detail by an indirect method of productivity analysis.

A systematic use of knowledge directed toward the design and production of useful prototypes, new materials, devices, systems, methods and manufacturing processes, develop many automotive product areas in which technological and market changes occur. Technological developments alter the capabilities urgently needed to profitably compete in the automotive market with the Japanese and European imports.

The sophisticated developed and applied technologies in the automotive industry sector today are: Computer aided design, computer aided manufacturing and computer aided production planning to enhance productivity growth.

Concepts of Productivity

G. Profit Measures

Profit is described as the difference between revenue and expenditure. Revenue depends on what an automotive corporation receives from selling automotive products, and is therefore affected by market influences such as competition. Expenditure is the side of the equation influenced by total factors productivity.[52] If the total factors productivity of a production system is as high as possible, expenditure is most likely to be at its lowest level.

Hence the two concepts are quite distinct because they are based on different factors. If productivity is high, the chances of profitability are that much higher. But there may well be automotive plants which are profitable and have a poor productivity, and others which do not make a profit despite high productivity simply because public is not buying the product.

Changes in the relative profit position [39] of the automotive corporations over the long run largely reflect their relative productivity performance. That is, since competing corporations are faced with much the same price changes in the market where they sell and buy, their profit margins depend on their relative degree of success in reducing real costs per unit of input (the reciprocal of increasing productivity). If a corporation's productivity increases more and thus unit real costs decline more than the average of the automotive industry, profit margins should improve relative to industry average.

H. Costs and Prices

Total costs of the firm for various output levels are the summation of the total fixed costs and total variable costs for those output levels.[40]

In the automotive industries, labour costs, including hourly rates of pay, salaries, overtime, and all types of fringe benefits, are the largest single cost element. Consequently, the trend of labour costs per unit of output plays a major role in determining the price per unit of output. If the effect of an increase in unit labour costs can be minimized by a greater increase in production, pressure to increase prices will obviously be lessened, although changes in profits or materials cost per unit of output may be able to offset this effect.

On the other hand, changes in unit labour costs can be a result as well as a cause of price rises. Price increases that cause employee purchasing power to fall lead to pressure for higher wages and/or salaries. If the wage and/or salary increases exceed productivity growth, unit labour costs increase also.[36]

Productivity movements are an important factor in determining price and cost stability. This aspect of productivity change stems from the role of output per man-hour -- an especially relevant concept when dealing with unit labour costs -- as a critical link between the cost of labour and the price of goods. Costs are inversely proportional to productivity growth.

I. Value Added

The concept of "value added" can be described as an input of materials and services to already existing production activity. Additional value added to the input by the direct and indirect labour efforts that transform materials into saleable goods.

The "value added" figures are compiled on the basis of the three activities: a) manufacturing activities, b) non-manufacturing activities, and c) total activities.

a) Figures are compiled for the manufacturing activities by deducting the cost of manufacturing materials, supplies, etc., and fuel and electricity consumed from the value of shipments of goods of own manufacture adjusted for changes in the value of inventories of finished goods and goods in progress.[75]

b) Compilation of statistical data for the non-manufacturing activities of the automotive industry is generated by subtracting the cost of goods purchased for re-sale (adjusted for changes in the value of inventories of goods purchased for re-sale) and the cost of non-manufacturing materials and supplies used from the value of shipments of goods not of own manufacture, plus other revenue.

c) In the total activities, the statistical data consist of value added contributed by manufacturing and non-manufacturing activities.[75] This total value added statistical data may, in some cases, be less than value added contributed by manufacturing activities as a result of expenditures associated with non-manufacturing activities. Revenues from non-manufacturing activities may not be able to exceed the expenditures of such activities or because of a decrease in inventory of goods not of own manufacture exceeding the mark-up on the sale of such goods.[76]

"Value added" concept is used as an index of productivity in two main ways: a) for the calculation of incentive increments in a total wage structure, and b) as part of a comprehensive and integrated range of management control data based upon ratios developed for specific purposes, such as:

$$\frac{\text{Value Added}}{\text{Labour Costs}} \quad \text{and} \quad \frac{\text{Value Added}}{\text{Total Costs}}$$

The first of these ratios can be defined as the financial productivity of the labour force, and the second ratio measures the financial productivity of all the company's resources, put together. The use of these ratios jointly or separately can, depending upon the automotive corporation's cost structure, be of vital importance as a control mechanism for management.

It is quite possible that such financial indexes will ultimately become the only productivity indicators accepted as valid or realistic.

Furthermore, value added per labour unit may be expressed in terms net labour productivity. The calculation of value added or net labour productivity is based on an estimate of the net product. The net product is defined as the difference between the gross value of the product and the total value of all other factors entering into the production cycle (including capital servicing charges)[53] expressed in constant dollars.

Value added per labour unit is obtained by dividing the net product thus computed by the amount of direct work expended in the production cycle. The concept of value added per labour unit is of importance in connection with the study of sectoral and/or national productivity.

In the content of the Canada - United States Automotive Products Trade Agreement [20], the Canadian government insisted on collateral commitments from the Canadian Motor Vehicle Manufacturers to increase, in each model year over the preceding model year, the dollar value of Canadian value added (C.V.A.) in the production of vehicles and original equipment parts by an amount equal to approximately 60 per cent of growth in the Canadian market.

J. Efficiency

The key to effective measurement of value added by an automotive corporation over a period of time is a measure of its productivity and efficiency. These two terms are often considered to be synonymous, but this is true only under certain conditions.

Efficiency may be defined as the optimum utilization of resources in the achievement of optimum value added. A productivity measure offers information that can imply efficiency in the use of a specific resource; but such a productivity measure cannot indicate overall efficiency of the automotive corporation or of a given project becouse increasing productivity in the use of labour resource for instance may be more than offset by the reduction in productivity of capital resorces.[53]

The level of efficiency can be estimated by evaluating all the signicant productivity measurements related to it. It is difficult to measure effecienty directly, but it can be inferred from a comprehensive productivity evaluation.

$$\text{The Efficiency Ratio} = \frac{\text{Standard Hours Produced}}{\text{Actual Hours Spent On Measured Work}} \times 100$$

K. <u>Quality</u>

The concepts of quality and productivity, which have often been contrasted, are closely related to each other in two ways:[52]

1. In estimating the productivity of the automotive industry, an improvement in technical quality is, strictly speaking, linked with an increase in quantity: with equal expenditure and for a constant quantity produced, an improvement in quality raises the productivity index.

2. On the other hand, productivity in the automotive industry is greatly influenced by the technical quality of the products used as production factors.

From the engineering point of view, quality, combined with quantity, is a factor in the evaluation of productivity. Other things being equal, a vehicle is of greater value if its quality renders it more useful to the user. One of the basic problems of purchase is to decide whether the price asked by the seller corresponds with the utility value provided by the quality of the vehicle.[39]

Quality of a vehicle may be divided into two categories: a) the pleasure it affords, or b) economy in use it provides to the user. The quality provided by the use of a vehicle may be called technical and it is objective insofar as economy in use is concerned. This technical quality has two further aspects: a) physical quality results from the mechanical properties of the vehicle considered, and b) functional quality, from its durability or convenience in use.

When the effort to improve the quality of a vehicle reaches its technical limits, the achievement of the higher quality would fail to bring a gain in satisfaction commensurate with the extra expenditure.

L. Total Labour Productivity

The concept of total labour productivity is evolved by including direct labour and indirect labour with other factors of production. Any outlay in dealing with raw materials, plants, or services of any kind can be expressed as an outlay in human labour. Labour is required to deal with these factors of production.[36] And, therefore, it is the basis of most evaluations. This concept inversely expresses the total unit cost of the output in terms of human labour. The total labour productivity concept emphasized here is to distinguish it from both total factors productivity and net labour productivity of direct labour.

$$\text{Total Labour Productivity} = \frac{\text{Production Output}}{\text{Direct Labour + Indirect Labour}}$$

M. <u>Net Labour Productivity</u>

The concept of net labour productivity is expressed in terms of the net product or value added divided over the direct labour. The net product is usually expressed in terms of dollar value becuase production and the factors of production are heterogeneous. [36]

The net product is defined as the difference between the gross value of the product and the total value of all the other factors entering into the production cycle.

These values for products and the factors of production must be expressed in terms of constant price dollar range, not at variable market prices.

The net labour productivity of an automotive corporation may be regarded as expressing the combined action of the two internal factors direct labour and capital. In this concept, the net product of the automotive corporation is the difference between gross product and total external factors (excluding capital): The Net Labour Productivity $= \frac{\text{Net Product Output}}{\text{Direct Labour}}$, or $Pnl - \frac{Onp}{Ld}$.

N. Partial Factor Productivity

The concept of partial factor productivity may be defined as the relationship between the total output and a partial associated input factor included in the production cycle of an automotive corporation. In practice, partial factor productivity can be and should be expressed in by an estimate in constant dollars, as the factors of production are usually heterogeneous. The effects of cost variations must be eliminated, particularly in comparative measurements where values of product output and input factors are required to be calculated by a constant dollar method. In the final analysis, productivity indexes calculated depend on the constant dollar system, used in relating outputs to inputs expressed in constant dollars also.

Partial factor productivity calculations are useful in providing comparative analysis among factors of input and their relative contribution to the total factor productivity.

Partial Factor Productivity $= \frac{\text{Total Output}}{\text{Partial Factor Input}}$

or, $P_{pt} = \frac{O_t}{I_{pf}}$.

O. Total Factors Productivity

Total productivity of the factors of production may be defined as the relationship between the total production output and total associated input factors, included in the production cycle of an automotive corporation. In practice, total productivity can most conveniently be expressed by an estimate in constant dollars, as the factors of production are usually heterogeneous. The effects of price variations must be eliminated, particularly in comparative measurements where values of product output and input factors are required to be calculated by a constant price method. In the final analysis, productivity indices obtained depend on the price system used in making comparisons between inputs and outputs.

The increase in total productivity indicated the total actual savings made on the total consumption of production factors. Lower costs may result from either a decrease of factor costs, or from more efficient factor utilization. The increase in total productivity of the factors of production thus reflects the lower cost achieved provided price fluctuation has been eliminated. However, this estimate is still affected by the price structure chosen as a basis for the evaluation. Total factors productivity is linked to the partial productivity of the various factors of inputs and outputs and it represents their weighted average. Total factors productivity = $\frac{\text{Production Output}}{\text{Total Factors Input}}$, or $P_{tf} = \frac{Ot}{I_{tf}}$.

CHAPTER V

MEASUREMENT OF PRODUCTIVITY LEVELS AND INDEXES

A. Methodology of Measurements

Motor Vehicle Manufacturers Industry as defined for statistical purposes in the Standard Industrial Classification Manual [82] covers the operations of establishments primarily engaged in manufacturing and/or assembling complete motor vehicles such as passenger automobiles, commercial cars and buses, trucks and special purpose motor vehicles such as ambulances and taxicabs.[75] Products manufactured and/or assembled by this branch of the automotive industry are classified under the S.I.C. #323. Statistics Canada provides diversified information for these establishments in its Catalog #42-209 and other publications designed to serve specific statistical purposes.

Motor vehicle Parts and Accessories Manufacturers Industry as defined for statistical purposes in the same Standard Industrial Classification Manual describes the operations of establishments primarily engaged in manufacturing and partial assembling of motor vehicle parts and accessories such as engines, brakes, clutches, axles, gears, heaters, air conditioners, radios, auxiliary power units, horns, mirrors, etc.[76] Products manufacturered and/or assembled by this branch of the automotive industry are classified under the S.I.C. #325. Statistics Canada reports various information for this industry branch in its Catalog #42-210 and other publications designed to serve specific statistical purposes.

A span of one decade has been taken into consideration for the study of productivity trends. The base year or the standard period commences with 1964 as the pre-Agreement year. The subsequent periods, 1965 through 1973, are being analyzed with the Canada - United States Automotive Products Trade Agreement of 1965 either in the process of being implemented or in full force.

The various indexes of output per unit of partial factor input presented in this study seek to measure the changing relationship between the volume of output in the automotive industry each year.

1. Output: The basic concept of output used in this study is that of total output at factor cost. Total output is, in the automotive manufacturing sector, essentially a measure of the contribution of the factors of production which are utilized in the transformation of raw materials into finished products. In practice, this concept has to be approximated by "census value added" which tends to overstate net output to the extent that it fails to exclude certain purchased services. Net output (census value added) cannot be expressed in real terms directly but only by the "double deflation" technique in which aggregate measures of gross output and intermediate inputs (materials, fuel, electricity, etc.) are separately calculated in real or constant dollar terms and the latter subtracted from the former.[80] Therefore, total output is expressed in terms of the value of shipments of goods of own

manufacture plus inventory adjustment (closing minus opening).

2. Input: The basic concept of labour input utilized in this study, i.e. labour time, is measured either by the man-years or man-hours expended within the automotive industry. The latter may be expressed either by measures of man-hours worked or man-hours paid and, then, expressed in constant dollars.

There is a need for measures of labour input in terms of both production and non-production workers. The persons employed in the automotive industry may be classified as follows:
a) "production and related workers", essentially all factory workers in manufacturing operations whether paid on a monthly, weekly, hourly or piece-work basis. Specific classes of workers defined as falling into this category are working foremen doing similar work to that of employees they supervise; also maintenance, warehousing and delivery staffs, etc.
b) "administrative and office employees" category is defined as including all executive and supervisory officials such as presidents, vice-presidents, secretaries, treasurers, managers, professional employees, superintendents and supervisors above the working foremen and their clerical staffs.[80]

Salaries and wages are reported before deductions for income tax and employee benefits and comprise all man-hours paid (for regular work, overtime and paid leave) as well as bonuses, commissions, etc., paid to regular employees. Where shown, production and related workers classified to non-manufacturing activity include separately reported loggers, employees on construction for own use, beginning with the 1970 Census outside pieceworkers formerly included for certain industries are excluded from all employment totals and their remuneration treated as contract work done by others. Sales and distribution employees include all personnel charged to selling expense, certain drivers, etc.[84]

Value Added: Net output as measured by gross output less purchased commodity inputs used and contract work by others.

a) Value added, manufacturing activity: Value of shipments of goods of own manufacture plus net change in inventory of goods in process and finished goods, less cost of materials and supplies used, fuel and electricity.

b) Value added, total activity: Consists of (1) value added, manufacturing activity and (2) value added, non-manufacturing activity. The latter ia calculated by subtracting relevant commodity inputs from non-manufacturing revenues or outputs; these commodity inputs are net of the change in inventories of goods purchased for resale. Non-manufacturing revenues include depreciable fixed assets produced by own work force for own use, revenue from product rentals, etc., but exclude non-operating revenue such as real property rentals, dividends, interest.[75]

<u>Cost of Materials and Supplies, Fuel and Electricity</u>: Generally, consumption of purchased items only, at laid-down cost. Includes inter-company and intracompany transfers, contract work by others, fuel used by vehicles.

<u>Inventories</u>: Book value of owned inventory held in Canada, including goods ~~in~~ transit and on consignment.

<u>Value of Shipments of Goods of Own Manufacture</u>: Goods made by reporting establishment, or for its account, from its own materials, net of discounts, return, allowances, sales taxes and duties, returnable containers, common or contract carriers' charges for outward transportation (but not of own carriers' delivery expense). Includes repair and custom revenue, transfers to reporting units of same firm,all exports, book value of own products shipped on rental basis. Unsold domestic consignment shipments are included in inventory.[76]

<u>Small Establishments</u>: For establishments filing "short forms", "cost of materials, supplies and services", includes all purchased services, and "total revenue excluding interest and dividends received" is used for both shipments of goods of own manufacture and gross output, total activity [76]. Value added is calculated using these figures and net change in total inventory and is thus indentical for manufacturing and and total activity.

B. Measurements of Productivity

The present study attempts to provide productivity measures of the Canadian automotive industry sector, taking into consideration three distinct concepts:

1. The Value Added Concept
2. The Sectoral Macroeconomic Model Concept
3. The Integrated Systems Concept

a.) The Value Added Concept may be used to measure productivity growth provided a sales volume or value of shipments of products and all other related inputs required for the model are available. The following value added model is considered for the measurement of productivity:

Productivity = (V-Q) ÷ (M+C) i.e. Value added per man

NOTES: Let V be the value of shipments
Let M be the input of manpower
Let C be the input of capital equipment
Let Q be the input of materials[26].

All values are to be expressed in constant dollars.

However, this concept as expressed above will not be utilized in computing the productivity measurements for the automotive industry sector due to the insufficiency of reliable information available at this time.

b.) The Sectoral Macroeconomic Model Concept may be utilized to measure productivity growth provided all the necessary factors of input and output required for the computation are available.

The concept of the sub-system is related to an existing production. The mathematical evaluation of the sub-system may be set out from as many as ten independent activities. Other algebraic comparisons of indexes of productivity for the automotive industry as a sub-sustem may be made as well. The comparisons are often made on the assumption of a closed economy [30] with single-product industries for each of which the product output is of a constant quality. Labour is also assumed to be of a constant quality and to be employed full time.

This model is concerned with the isolation of a self-sufficient sector from its economy. The automotive industry sector can be classified as a self-sufficient sector and, therefore, it can be called a sub-system. The principal use of the sub-system is to eliminate the many analytical difficulties arising from the interdependence of a set of activities, whether they are processes within a corporation or corporations within the industry sector[30]. In this way the information about a complex multi-activity system is improved.

To illustrate this model, productivity indexes related to the sub-system [30] can be constructed as follows:

1. Total Factors Output:

$$Ot_f = [t_1(1 - U_{i1})]$$

2. Total Factors Input:

$$It_f = [\Phi_1 - \sum_{k=1}^{n} x_{k_1}]$$

3. Total Factors Productivity Index:

$$Ptf = [t_1 \ (1-U_{i1})] \div [\phi_1 - \sum_{k=1}^{n} X_{k_1}]$$

NOTES:

t_1 = Total gross sales of activity 1.

X_{k_1} = Sales of activity "k" to activity 1.

U_{i1} = Market share coefficient goes from activity i to activity 1. (expressed in percentages)

ϕ_1 = Gross input of activity 1.

All variables t_1, ϕ_1, ν and X_{ij} are expressed in terms of constant dollars, and i, U, K=1,2,...n, are general activity numbers.

It is a common knowledge that motor vehicle manufacturers do purchase from each other, particularly smaller from the larger ones, certain parts, part assemblies and complete assemblies such as engines, automatic transmissions, engine block castings, etc. However, there is no sufficient information published in this regard by the Statistics Canada and/or other publishing agencies to reliably utilize the sectoral macro-economic model for the measurements of productivity in the Canadian Automotive industry sector.

c.) <u>The Integrated Systems Concept</u> of measuring productivity is designed to provide computation of the performance of the total sectoral production system over the selected period of one decade, expressed in the index form and real terms. It is based on a total output per year achieved and the cost of total factors input per the same year utilized in a sequence of compared periods of the total manufacturing system.

The total factors productivity index is computed by means of the model:

$$Pt = [\frac{Qt}{Qo} \div \frac{It}{Io}] \times 100\%$$

NOTES: P - The total factors productivity index

Q - The total output in constant dollars

I - The total factors input in constant dollars

o - The base year (standard period)

t - The current year (subsequent period) [72].

EXAMPLE: ($'000,000 Omitted)

1964 - Standard Period $\frac{1,673}{1,673} \div \frac{1,079}{1,079}$ X 100% = 100.00 = 0.00%

1965 - Subsequent Period $\frac{2,130}{1,673} \div \frac{1,292}{1,079}$X 100% = 105.80 = 5.80%

1966 - Subsequent Period $\frac{2,190}{1,673} \div \frac{1,318}{1,079}$X 100% = 107.20 = 7.20%

These index figures represent the size of the improvements taking place in the level of productivity as changes are made to the motor vehicle production system during the subsequent periods.

The main requirement of the productivity index stems from the provision in the Integrated Systems Concept of measurement for comparisons to be made between the standard period (immediately preceding the implementation of changes to the production system) and the subsequent periods [59].

The partial factor productivity index is computed by means of the similar model:

$$Pt = [\frac{Qt}{Qo} \div \frac{Ft}{Fo}] \times 100\%$$

NOTES: P - Partial factor productivity index

Q - The total output in constant dollars

F - Partial factor input in constant dollars

o - The base year (standard period)

t - The current year (subsequent period) [72].

EXAMPLE: ($ '000,000 Omitted)

1964 - Standard Period $\frac{1,673}{1,673} \div \frac{627}{627} \times 100\% = 100.00 = 0.00\%$

1965 - Subsequent Period $\frac{2,131}{1,673} \div \frac{743}{627} \times 100\% = 107.43 = 7.43\%$

1966 - Subsequent Period $\frac{2,190}{1,673} \div \frac{806}{627} \times 100\% = 101.87 = 1.87\%$

These index figures represent the size of the improvement contributed to the level of productivity by one particular input factor, fuel and electricity, as changes are affected in the motor vehicle production system during the subsequent periods. The computation of the level of productivity commenced in 1964 for a standard period or a base pre-agreement year. The level of productivity and the productivity index in the base year becomes a yardstick with which all subsequent period levels of productivity are compared.

The primary source for the measures of output and intermediate inputs of the automotive industry sector dealt with in this study is the Annual Census of Manufacturers, the empirical data which are available for the entire period covered in the form suitable for productivity measurement purposes[80]. Statistical tables, in the appendix section, are prepared in accordance with the Annual Census empirical data as published by Statistics Canada. The tables contain principal statistics (Tables #1 and #2), other necessary statistical data (Tables #3 and #4) expressed in current dollars and the production deflators(Table #7) for both Motor Vehicle and Parts and Accessories Manufacturers of Canada.

In the computation of productivity indexes, both output and input must be expressed in real terms or constant dollars. Measures of constant dollar values are derived by the deflation of current dollar values of output and intermidiate input with appropriate deflators (Table #7).

The publication of a set of Wholesale Prices Indexes[79] for Motor Vehicle Manufacturers and Parts and Accessories Manufacturers, compiled and presented at the three-digit level of the Standard Industrial Classification, affords a much more realistic basis for output and input deflation. Output, input and value added data computed and compiled (Exhibits #1 and #2) in current dollars for both Motor Vehicle Manufacturers and Parts and Accessories Manufacturers are deflated

(Exhibit #3) for the calculation of productivity indexes.

Statistical data and the productivity indexes thereof have been computed, indexed in the appendix, and tabulated in various exhibits to provide the necessary information for the plotting of relative trends of performance in the Canadian Automotive macroeconomic sector and the productivity trend analyses based on them.

Exhibit#1

TOTAL MANUFACTURING AND NON-MANUFACTURING ACTIVITIES

(Motor Vehicle Manufacturers)

CURRENT DOLLARS

($'000 Omitted)

Year	Total Output Per Year	Total Input Per Year	Total Value Added Per Year
1964	1,694,929	1,156,852	548,077
1965	2,145,465	1,412,690	732,775
1966	2,188,260	1,471,237	717,023
1967	2,484,486	1,541,362	943,124
1968	3,033,913	1,980,159	1,053,754
1969	3,542,866	2,382,928	1,159,938
1970	2,976,676	2,107,481	869,195
1971	3,682,438	2,501,867	1,180,571
1972	4,046,691	2,684,620	1,362,071
1973	4,752,384	3,201,624	1,551,760

Exhibit #2

TOTAL MANUFACTURING AND NON-MANUFACTURING ACTIVITIES

(MOTOR VEHICLE PARTS AND ACCESSORIES MANUFACTURERS)

$'000 Omitted (Current Dollars)

Year	Output	Input	Value Added
1964	627,966	342,152	285,814
1965	755,608	422,241	333,367
1966	860,500	475,979	384,521
1967	912,422	502,167	410,255
1968	1,193,805	672,316	521,489
1969	1,340,376	722,413	617,963
1970	1,272,154	722,901	549,253
1971	1,660,665	906,665	753,828
1972	1,903,161	1,027,119	876,042
1973	2,304,562	1,260,949	1,043,613

Exhibit #3

PRODUCTION DATA DEFLATED

CONSTANT DOLLARS

($'000 Omitted)

Year	Motor Vehicle Manufacturers			Motor Vehicle Parts and Accessories Manufacturers		
	Total Output Per Year	Total Input Per Year	Total Value Added Per Year	Total Output Per Year	Total Input Per Year	Total Value Added Per Year
1964	1,673,178	1,079,455	593,723	609,676	323,609	286,067
1965	2,130,551	1,292,016	838,535	725,152	388,160	336,992
1966	2,190,450	1,318,313	872,137	820,305	428,810	391,495
1967	2,486,972	1,339,965	1,147,007	856,734	438,497	418,237
1968	2,980,268	1,673,138	1,307,130	1,106,399	574,973	532,426
1969	3,453,086	1,944,771	1,508,315	1,216,312	594,138	622,174
1970	2,864,944	1,699,581	1,165,463	1,128,797	581,578	547,219
1971	3,457,688	1,968,424	1,489,264	1,452,900	719,233	733,667
1972	3,722,807	2,069,390	1,653,417	1,633,615	799,377	834,238
1973	4,044,434	2,486,119	1,558,315	1,904,597	944,885	959,712

Exhibit #4

PRODUCTION DATA DEFLATED

Motor Vehicle Manufacturers

CONSTANT DOLLARS

($'000,000,000 Omitted)

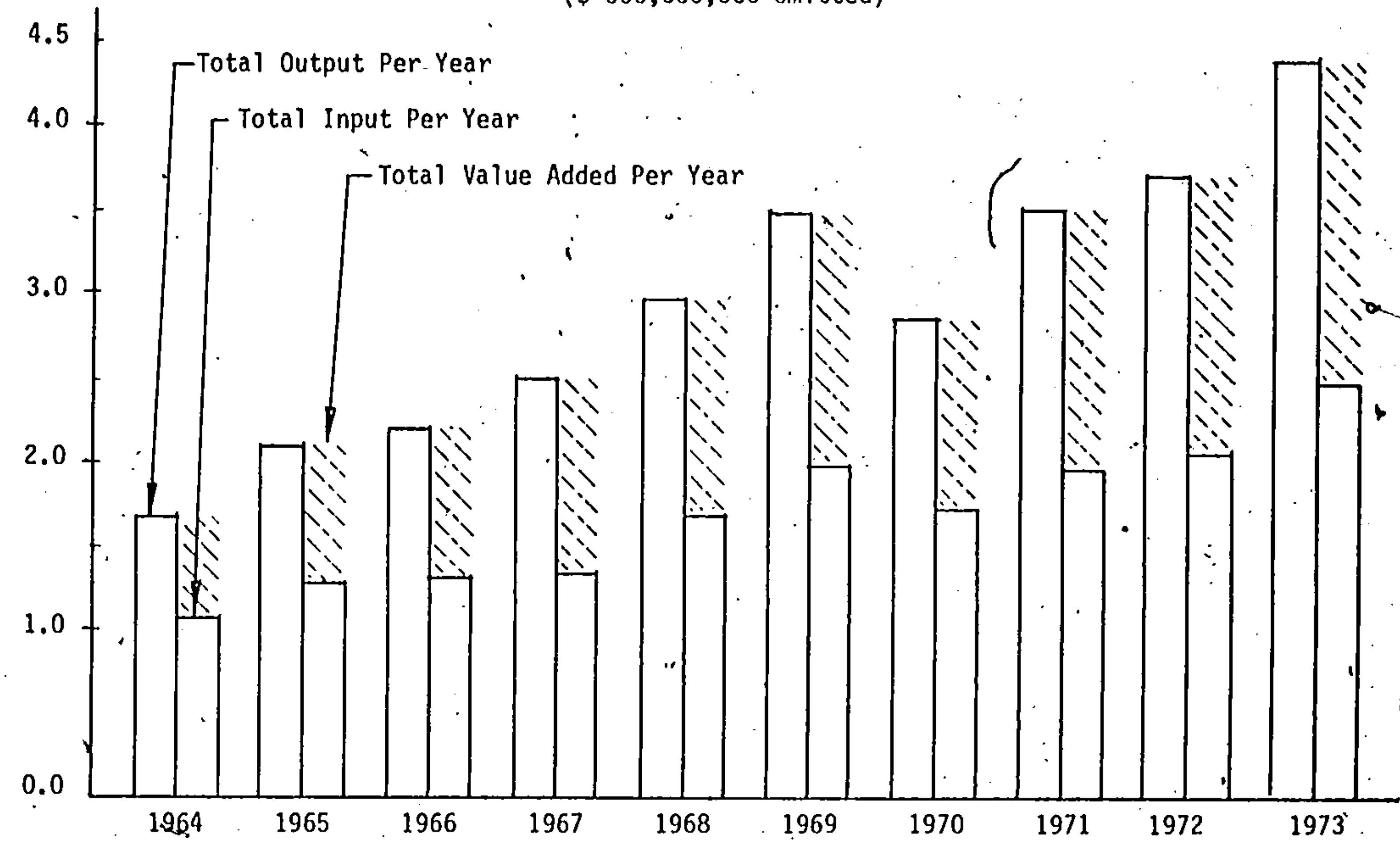


Exhibit #5

PRODUCTION DATA DEFLATED

Parts and Accessories Manufacturers

CONSTANT DOLLARS

($'000,000,000 Omitted)

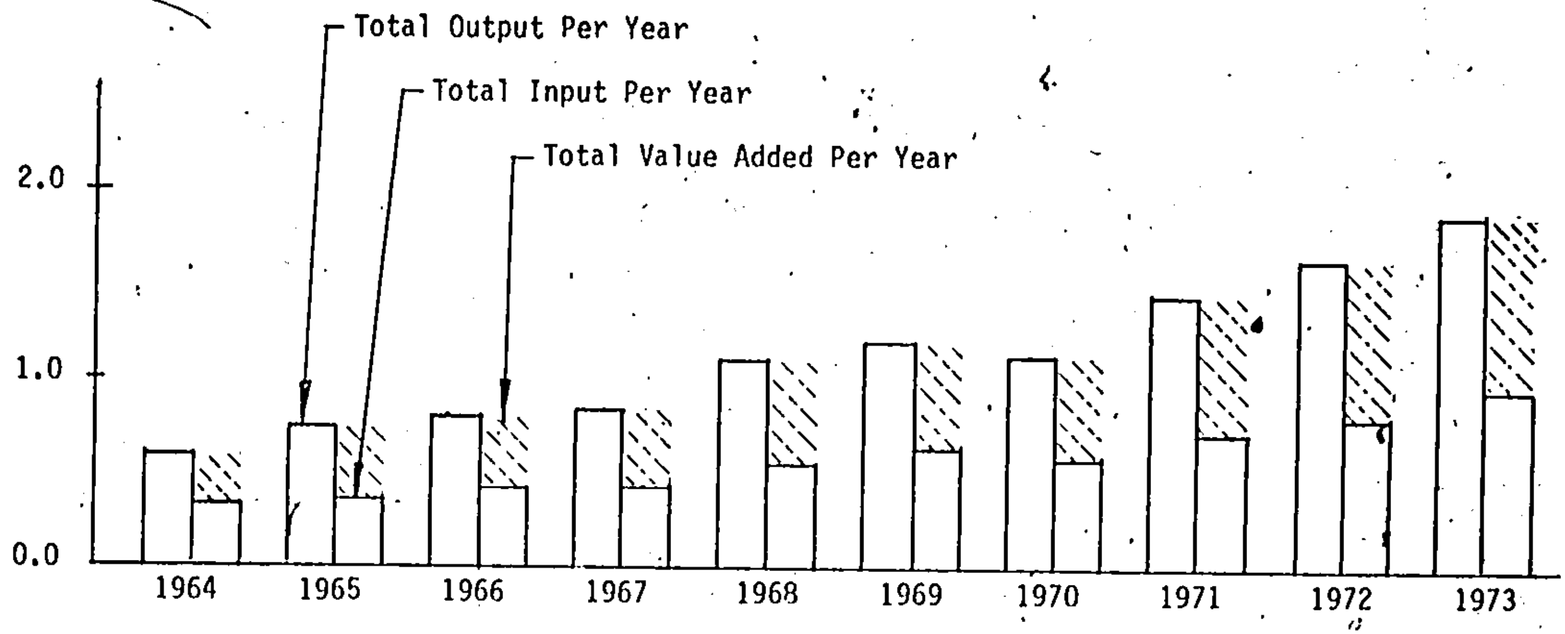


Exhibit #6

PARTIAL FACTORS INPUT DATA DEFLATED

CONSTANT DOLLARS

($'000 Omitted)

Year	Motor Vehicle Manufacturers			Motor Vehicle Parts and Accessories Manufacturers		
	Fuel and Electricity Input	Materials and Supplies Input	Total Labour Input	Fuel and Electricity Input	Materials and Supplies Input	Total Labour Input
1964	6,270	1,125,719	218,859	6,761	335,059	159,068
1965	7,432	1,377,308	276,731	8,086	384,978	181,470
1966	8,058	1,403,446	276,839	9,629	434,375	186,639
1967	8,739	1,489,612	267,804	10,279	438,120	188,027
1968	9,693	1,854,887	295,318	11,856	571,276	240,029
1969	10,422	2,118,689	313,346	11,198	613,290	258,569
1970	9,781	1,854,939	299,842	11,509	576,776	249,054
1971	11,264	2,216,998	346,912	14,209	712,707	310,965
1972	12,138	2,408,204	394,247	15,978	800,528	341,655
1973	12,947	2,874,564	459,543	17,813	953,265	410,518

CALCULATION OF PRODUCTIVITY

Exhibit #7

Motor Vehicle Manufacturers
CONSTANT DOLLARS
($'000 Omitted)

Year	Productivity Level	Productivity Index
1964	$\frac{1,673,178}{1,079,455} = 1.550$	$\frac{1.550}{1.550} \times 100\% = 100.0 - 0.0\%$
1965	$\frac{2,130,551}{1,299,016} = 1.640$	$\frac{1.640}{1.550} \times 100\% = 105.8 - 5.8$
1966	$\frac{2,190,450}{1,318,313} = 1.662$	$\frac{1.662}{1.550} \times 100\% = 107.2 - 7.2$
1967	$\frac{2,486,972}{1,339,965} = 1.856$	$\frac{1.856}{1.550} \times 100\% = 119.7 - 19.7$
1968	$\frac{2,980,268}{1,673,138} = 1.781$	$\frac{1.781}{1.550} \times 100\% = 114.9 - 14.9$
1969	$\frac{3,453,086}{1,944,771} = 1.776$	$\frac{1.776}{1.550} \times 100\% = 114.6 - 14.6$
1970	$\frac{2,864,944}{1,699,581} = 1.686$	$\frac{1.686}{1.550} \times 100\% = 108.8 - 8.8$
1971	$\frac{3,457,688}{1,968,424} = 1.757$	$\frac{1.757}{1.550} \times 100\% = 113.4 - 13.4$
1972	$\frac{3,722,807}{2,069,390} = 1.799$	$\frac{1.799}{1.550} \times 100\% = 116.1 - 16.1$
1973	$\frac{4,404,434}{2,486,119} = 1.772$	$\frac{1.772}{1.550} \times 100\% = 114.3 - 14.3$

Cumulative Total = 115.8 %

Average Per Year = 12.9 %

CALCULATION OF PRODUCTIVITY

Exhibit #8

Parts and Accessories Manufacturers
CONSTANT DOLLARS
($'000 Omitted)

Year	Productivity Level	Productivity Index	
1964	$\frac{609,676}{323,609} = 1.884$	$\frac{1.884}{1.884} \times 100\% = 100.0$	- 0.0 %
1965	$\frac{725,152}{388,160} = 1.868$	$\frac{1.868}{1.884} \times 100\% = 99.2$	-(0.8)
1966	$\frac{820,305}{428,810} = 1.913$	$\frac{1.913}{1.884} \times 100\% = 101.5$	- 1.5
1967	$\frac{856,734}{438,497} = 1.954$	$\frac{1.954}{1.884} \times 100\% = 103.7$	- 3.7
1968	$\frac{1,106,399}{574,973} = 1.924$	$\frac{1.924}{1.884} \times 100\% = 102.1$	- 2.1
1969	$\frac{1,216,312}{594,138} = 2.047$	$\frac{2.047}{1.884} \times 100\% = 108.7$	- 8.7
1970	$\frac{1,128,797}{581,578} = 1.941$	$\frac{1.941}{1.884} \times 100\% = 103.0$	- 3.0
1971	$\frac{1,452,900}{719,233} = 2.020$	$\frac{2.020}{1.884} \times 100\% = 107.2$	- 7.2
1972	$\frac{1,633,615}{799,377} = 2.044$	$\frac{2.044}{1.884} \times 100\% = 108.5$	- 8.5
1973	$\frac{1,904,597}{944,885} = 2.016$	$\frac{2.016}{1.884} \times 100\% = 107.0$	- 7.0

Cumulative Total = 40.9 %

Average Per Year = 4.54%

CALCULATION OF PARTIAL FACTOR PRODUCTIVITY INDEX Exhibit #9

(Total Labour)

Motor Vehicle Manufacturers

CONSTANT DOLLARS

($'000 Omitted)

Year					
1964	$\frac{1,673,178}{1,673,178} \div \frac{218,859}{218,859}$	x 100%	= 100.00	-	0.0 %
1965	$\frac{2,130,551}{1,673,178} \div \frac{276,731}{218,859}$	x 100%	= 100.71	-	.71%
1966	$\frac{2,190,450}{1,673,178} \div \frac{276,839}{218,859}$	x 100%	= 103.47	-	3.47
1967	$\frac{2,486,972}{1,673,178} \div \frac{267,804}{218,859}$	x 100%	= 121.40	-	21.40
1968	$\frac{2,980,268}{1,673,178} \div \frac{295,318}{218,859}$	x 100%	= 132.02	-	32.02
1969	$\frac{3,453,086}{1,673,178} \div \frac{313,346}{218,859}$	x 100%	= 144.06	-	44.06
1970	$\frac{2,864,944}{1,673,178} \div \frac{299,842}{218,859}$	x 100%	= 124.96	-	24.96
1971	$\frac{3,457,688}{1,673,178} \div \frac{346,912}{218,859}$	x 100%	= 130.41	-	30.41
1972	$\frac{3,722,807}{1,673,178} \div \frac{394,247}{218,859}$	x 100%	= 123.54	-	23.54
1973	$\frac{4,044,434}{1,673,178} \div \frac{459,543}{218,859}$	x 100%	= 115.09	-	15.09
			CUMULATIVE Total		195.66%
			Average Per Year		21.74%

EXHIBIT #10

CALCULATION OF PARTIAL FACTOR

PRODUCTIVITY INDEX

(TOTAL LABOUR)

Parts and Accessories Manufacturers
(Constant Dollars)
(000's Omitted)

YEAR									
1964	$\frac{609,676}{609,676}$	÷	$\frac{159,068}{159,068}$	x	100%	=	100.0	=	0.00%
1965	$\frac{725,152}{609,676}$	÷	$\frac{181,470}{159,068}$	x	100%	=	104.21	=	4.21%
1966	$\frac{820,305}{609,676}$	÷	$\frac{186,639}{159,068}$	x	100%	=	114.66	=	14.66%
1967	$\frac{856,734}{609.676}$	÷	$\frac{188,027}{159,068}$	x	100%	=	125.72	=	25.72%
1968	$\frac{1,106,399}{609,676}$	÷	$\frac{240,021}{159.068}$	x	100%	=	118.21	=	18.21%
1969	$\frac{1,216,312}{609,676}$	÷	$\frac{258,569}{159,068}$	x	100%	=	122.69	=	22.69%
1970	$\frac{1,128,797}{609.676}$	÷	$\frac{249,054}{159.068}$	x	100%	=	113.84	=	13.84%
1971	$\frac{1,452,900}{609,676}$	÷	$\frac{310,965}{159,068}$	x	100%	=	121.89	=	21.89%
1972	$\frac{1,633,615}{609,676}$	÷	$\frac{341,655}{159,068}$	x	100%	=	124.72	=	24.72%
1973	$\frac{1,904,597}{609.676}$	÷	$\frac{410,518}{159,068}$	x	100%	=	128.34	=	28.34%

CUMULATIVE TOTAL	174.28%
AVERAGE PER YEAR	19.36%

EXHIBIT #11

CALCULATION OF PARTIAL FACTOR PRODUCTIVITY INDEX (MATERIALS AND SUPPLIES)

Motor Vehicle Manufacturers
(Constant Dollars)
(000's Omitted)

YEAR				
1964	$\frac{1,673,178}{1,673,178} \div \frac{1,125,719}{1,125,719} \times 100\%$	= 100.0	=	0.00%
1965	$\frac{2,130,551}{1,673,178} \div \frac{1,377,308}{1,125,719} \times 100\%$	= 104.09	=	4.09%
1966	$\frac{2,190,450}{1,673,178} \div \frac{1,403,446}{1,125,719} \times 100\%$	= 104.97	=	4.97%
1967	$\frac{2,486,972}{1,673,178} \div \frac{1,489,612}{1,125,719} \times 100\%$	= 112.32	=	12.32%
1968	$\frac{2,980,268}{1,673,178} \div \frac{1,854,887}{1,125,719} \times 100\%$	= 108.07	=	8.07%
1969	$\frac{3,453,086}{1,673,178} \div \frac{2,118,689}{1,125,719} \times 100\%$	= 109.62	=	9.62%
1970	$\frac{2,864,944}{1,673,178} \div \frac{1,854,939}{1,125,719} \times 100\%$	= 103.88	=	3.88%
1971	$\frac{3,457,688}{1,673,178} \div \frac{2,216,998}{1,125,719} \times 100\%$	= 104.98	=	4.98%
1972	$\frac{3,722,807}{1,673,178} \div \frac{2,408,204}{1,125,719} \times 100\%$	= 104.02	=	4.02%
1973	$\frac{4,044,434}{1,673,178} \div \frac{2,874,564}{1,125,719} \times 100\%$	= 94.64	=	5.36%
	CUMULATIVE TOTAL			46.49%
	AVER/ PER YEAR			5.17%

EXHIBIT #12

CALCULATION OF PARTIAL FACTOR PRODUCTIVITY INDEX (MATERIALS AND SUPPLIES)

Parts and Accessories Manufacturers
(Constant Dollars)
(000's Omitted)

YEAR										
1964	$\frac{609,676}{609,676}$	÷	$\frac{335,978}{335,059}$	x	100%	=	100.00	=	0.00%
1965	$\frac{725,152}{609,676}$	÷	$\frac{384,978}{335,059}$	x	100%	=	103.85	=	3.85%
1966	$\frac{820,305}{609,676}$	÷	$\frac{434,375}{335,059}$	x	100%	=	103.78	=	3.78%
1967	$\frac{856,734}{609,676}$	÷	$\frac{438,120}{335,059}$	x	100%	=	107.42	=	7.42%
1968	$\frac{1,106,399}{609,676}$	÷	$\frac{571,276}{335,059}$	x	100%	=	106,45	=	6.45%
1969	$\frac{1,216,312}{609,676}$	÷	$\frac{613,290}{335,059}$	x	100%	=	109.02	=	9.02%
1970	$\frac{1,128,797}{609,676}$	÷	$\frac{576,776}{335,059}$	x	100%	=	105.46	=	5.46%
1971	$\frac{1,452,900}{609,676}$	÷	$\frac{712,707}{335,059}$	x	100%	=	112.04	=	12.04%
1972	$\frac{1,633,615}{609,676}$	÷	$\frac{800,528}{335,059}$	x	100%	=	112.14	=	12.14%
1973	$\frac{1,904,597}{609,676}$	÷	$\frac{953,265}{335,059}$	x	100%	=	109.81	=	9.81%
					CUMULATIVE TOTAL				69.97%
					AVERAGE PER YEAR				7.77%

EXHIBIT #13

CALCULATION OF PARTIAL FACTOR
PRODUCTIVITY INDEX
(FUEL AND ELECTRICITY)

Motor Vehicle Manufacturers
(Constant Dollars)
(000's Omitted)

YEAR									
1964	$\frac{1,673,178}{1,673,178}$	÷	$\frac{6,270}{6,270}$	x	100%	=	100.00	-	0.0%
1965	$\frac{2,130,551}{1,673,178}$	÷	$\frac{7,432}{6,270}$	x	100%	=	107.43	-	7.43%
1966	$\frac{2,190,450}{1,673,178}$	÷	$\frac{8,058}{6,270}$	x	100%	=	101.87	-	1.87%
1967	$\frac{2,486,972}{1,673,178}$	÷	$\frac{8,739}{6,270}$	x	100%	=	106.67	-	6.67%
1968	$\frac{2,980,268}{1,673,178}$	÷	$\frac{9,693}{6,270}$	x	100%	=	115.20	-	15.20%
1969	$\frac{3,453,086}{1,673,178}$	÷	$\frac{10,422}{6,270}$	x	100%	=	124.13	-	24.13%
1970	$\frac{2,864,944}{1,673,178}$	÷	$\frac{9,781}{6,270}$	x	100%	=	109.74	-	9.74%
1971	$\frac{3,457,688}{1,673,178}$	÷	$\frac{11,264}{6,270}$	x	100%	=	115.09	-	15.09%
1972	$\frac{3,722,807}{1,673,178}$	÷	$\frac{12,138}{6,270}$	x	100%	=	114.93	-	14.93%
1973	$\frac{4,044,434}{1,673,178}$	÷	$\frac{12,947}{6,270}$	x	100%	=	117.05	-	17.05%
				CUMULATIVE TOTAL					112.11%
				AVERAGE PER YEAR					12.46%

EXHIBIT #14

CALCULATION OF PARTIAL FACTOR

PRODUCTIVITY INDEX

(FUEL AND ELECTRICITY)

Parts and Accessories Manufacturers
(Constant Dollars)
(000's Omitted)

YEAR									
1964	$\frac{609,676}{609,676}$	÷	$\frac{6,761}{6,761}$	x	100%	=	100.00	=	0.00%
1965	$\frac{725,152}{609,676}$	÷	$\frac{8,086}{6,671}$	x	100%	=	99.44	=	-0.56%
1966	$\frac{820,305}{609,676}$	÷	$\frac{9,629}{6,671}$	x	100%	=	94.45	=	-5.55%
1967	$\frac{856,734}{609,676}$	÷	$\frac{10,279}{6,671}$	x	100%	=	92.43	=	-7.57%
1968	$\frac{1,106,399}{609,676}$	÷	$\frac{11,856}{6,671}$	x	100%	=	103.48	=	3.48%
1969	$\frac{1,216,312}{609,676}$	÷	$\frac{11,198}{6,671}$	x	100%	=	120.47	=	20.47%
1970	$\frac{1,128,797}{609,676}$	÷	$\frac{11,509}{6,671}$	x	100%	=	108.75	=	8.75%
1971	$\frac{1,452,900}{609,676}$	÷	$\frac{14,209}{6,671}$	x	100%	=	113.37	=	13.37%
1972	$\frac{1,633,615}{609,676}$	÷	$\frac{15,978}{6,671}$	x	100%	=	113.37	=	13.37%
1973	$\frac{1,904,597}{609,676}$	÷	$\frac{17,813}{6,671}$	x	100%	=	118.56	=	18.56%

CUMULATIVE TOTAL	64.32%
AVERAGE PER YEAR	7.15%

EXHIBIT #15

CORPORATION FINANCIAL DATA DEFLATED, 1965-1974
(MOTOR VEHICLE AND PARTS AND ACCESSORIES MANUFACTURERS)
CONSTANT DOLLARS ($'000,000 OMITTED)

	1965	1966	1967	1968	1969	1970	1971	1972	1973
No. of Corp.	212	196	191	206	215	215	189	227	234
Total Assets	1,288.6	1,552.9	1,715.7	1,801.4	1,855.2	1,851.7	1,914.0	2,595.7	3,011.8
Total Liabilities	644.1	929.5	1,029.3	1.027.8	875.3	868.0	859.7	1,201.2	1,454.0
Total Equity	644.4	623.6	687.2	773.8	979.8	983.7	1,054.3	1,394.4	1,557.8
Total Liab. &Equity	1,288.6	1,553.1	1,720.9	1,801.4	1,855.2	1,851.7	1.914.0	2.595.7	3,011.8
Total Income	2,843.7	3,159.8	3,640.3	4,328.3	5,199.8	4,536.3	5,622.8	7,785.0	8.781.5
Total Deductions	2,787.3	3,099.8	3,549.0	4,077.7	4,907.4	4,406.7	5,307.3	7,288.1	8.302.1
Net Profit	106.4	59.9	91.3	143.8	159.5	73.2	172.8	295.7	283.9
RETAINED EARNINGS:									
Opening Balance	549.6	578.9	528.3	571.3	669.1	826.0	825.7	1,076.5	1,224.2
Net Profit	106.4	59.9	91.3	143.8	159.5	73.2	172.8	295.7	283.9
Dividends	65.3-	98.7-	21.6-	21.4-	17.6-	26.8-	71.0-	123.8-	121.7-
Other Credits	1.6	5.6	3.4-	1.2	25.1	34.4-	3.9	.01-	72.9-
Closing Balance	593.7	545.9	596.0	694.6	836.2	838.1	918.5	1,232.8	1,376.0

EXHIBIT #16

AGGREGATE SECTOR OUTPUT

(MOTOR VEHICLE AND PARTS AND ACCESSORIES MANUFACTURERS)

CONSTANT DOLLARS ($'000,000 Omitted)

1964	2,282.8
1965	2,855.7
1966	3,010.8
1967	3,343.7
1968	4,086.7
1969	4,669.4
1970	3,993.7
1971	4,910.8
1972	5,356.4
1973	5,949.0

EXHIBIT #17

CALCULATION OF PARTIAL FACTOR

PRODUCTIVITY INDEX

(TOTAL ASSETS)
(MOTOR VEHICLE AND PARTS AND ACCESSORIES MANUFACTURERS)
($'000,000 OMITTED) CONSTANT DOLLARS

YEAR				PRODUCTIVITY INDEX	
1965	$\frac{2,855.7}{2,855.7} \div \frac{1,288.6}{1,288.6}$	x	100% =	100.00	= 0.00%
1966	$\frac{3,010.8}{2,855.7} \div \frac{1,552.9}{1,288.6}$	x	100% =	86.8	= -13.2%
1967	$\frac{3,343.7}{2,855.7} \div \frac{1,715.7}{1,288.6}$	x	100% =	83.6	= -16.4%
1968	$\frac{4,086.7}{2,855.7} \div \frac{1,801.4}{1,288.6}$	x	100% =	102.14	= 2.1%
1969	$\frac{4,669.4}{2,855.7} \div \frac{1,855.2}{1,288.6}$	x	100% =	113.9	= 13.9%
1970	$\frac{3,993.7}{2,855.7} \div \frac{1,851.7}{1,288.6}$	x	100% =	97.2	= -2.8%
1971	$\frac{4,910.6}{2,855.7} \div \frac{1,914.0}{1,288.6}$	x	100% =	115.4	= 15.4%
1972	$\frac{5,356.4}{2,855.7} \div \frac{2,595.7}{1,288.6}$	x	100% =	93.5	= -6.5%
1973	$\frac{5,949.0}{2,855.7} \div \frac{3,011.8}{1,288.6}$	x	100% =	88.9	= -11.1%

CUMULATIVE TOTAL $-18.6%

Average Per Year $ -2.3%

EXHIBIT #18

PRODUCTIVITY INDEX OF VALUE-ADDED

PER EMPLOYEE

(CONSTANT DOLLARS)

YEAR	MOTOR VEHICLE MANUFACTURERS	PARTS AND ACCESSORIES MANUFACTURERS
1964	$16,480 = 100 = 0.00%	$9,716 = 100 = 0.00%
1965	19,762 = 120 = 20%	10,537 = 108 = 8%
1966	20,517 = 124 = 24%	11,263 = 116 = 16%
1967	28,071 = 170 = 70%	11,998 = 123 = 23%
1968	25,568 = 155 = 55%	13,460 = 139 = 39%
1969	35,984 = 218 = 118%	14,977 = 154 = 54%
1970	30,553 = 185 = 85%	14,080 = 145 = 45%
1971	35,180 = 213 = 113%	16,747 = 172 = 72%
1972	37,542 = 227 = 127%	18,061 = 186 = 86%
1973	33,275 = 202 = 102%	18,161 = 187 = 87%
	CUMULATIVE TOTAL = 714%	CUMULATIVE TOTAL = 430%
	Average Per Year =79.3%	Average Per Year =47.8%

EXHIBIT #19

PRODUCTIVITY INDEX OF VALUE-ADDED

PER FUEL AND ELECTRICITY INPUT

CONSTANT DOLLARS ($'000,000 OMITTED)

YEAR	MOTOR VEHICLE MANUFACTURERS	PARTS AND ACCESSORIES MANUFACTURERS
1964	$ 593,723 / 6,270 = 94.7 = 100 = 0.00%	$286,067 / 6,761 = 42.3 = 100 = 0.00%
1965	838,535 / 7,432 = 112.8 = 119 = 19%	336,992 / 8,086 = 41.7 = 99 = (-1%)
1966	872,137 / 8,058 = 108.2 = 114 = 14%	391,495 / 9,629 = 40.7 = 96 = (-4%)
1967	1147,007 / 8,739 = 131.3 = 139 = 39%	418,237 / 10,279 = 40.7 = 96 = (-4%)
1968	1307,130 / 9,693 = 134.9 = 142 = 42%	532,426 / 11,856 = 44.9 = 106 = 6%
1969	1508,315 / 10,422 = 144.7 = 153 = 53%	622,174 / 11,198 = 55.6 = 131 = 31%
1970	1165,463 / 9,781 = 119.2 = 126 = 26%	547,219 / 11,509 = 47.6 = 113 = 13%
1971	1489,264 / 11,264 = 132.2 = 140 = 40%	733,667 / 14,209 = 51.6 = 122 = 22%
1972	1653,417 / 12,138 = 136.2 = 144 = 44%	834,238 / 15,978 = 52.2 = 123 = 23%
1973	1558,315 / 12,947 = 120.4 = 127 = 27%	959,712 / 17,813 = 53.9 = 127 = 27%
	CUMULATIVE TOTAL = 304%	CUMULATIVE TOTAL = 113%
	Aver/Year = 33.8%	Aver/Year = 12.6%

EXHIBIT #20

PRODUCTIVITY INDEX OF VALUE-ADDED
PER MATERIALS AND SUPPLIES INPUT
CONSTANT DOLLARS ($'000 OMITTED)

YEAR	MOTOR VEHICLE MANUFACTURERS	PARTS AND ACCESSORIES MANUFACTURERS
1964	$\frac{\$\ 593,793}{1,125,719}$ = .48 = 100 = 0%	$\frac{\$286,067}{335,059}$ = .85 = 100 = 0%
1965	$\frac{838,535}{1,377,308}$ = .61 = 127 = 27%	$\frac{336,992}{384,478}$ = .88 = 104 = 4%
1966	$\frac{872,137}{1,403,446}$ = .62 = 129 = 29%	$\frac{391,495}{434,375}$ = .90 = 106 = 6%
1967	$\frac{1,147,007}{1,489,612}$ = .77 = 160 = 60%	$\frac{418,237}{438,120}$ = .95 = 112 = 12%
1968	$\frac{1,307,130}{1,854,887}$ = .70 = 146 = 46%	$\frac{532,426}{571,276}$ = .93 = 109 = 9%
1969	$\frac{1,508,315}{2,118,689}$ = .71 = 148 = 48%	$\frac{622,174}{613,290}$ = 1.01 = 119 = 19%
1970	$\frac{1,165,463}{1,854,934}$ = .63 = 131 = 31%	$\frac{547,219}{576,776}$ = .95 = 112 = 12%
1971	$\frac{1,489,264}{2,216,998}$ = .67 = 140 = 40%	$\frac{733,667}{712,707}$ = 1.03 = 121 = 21%
1972	$\frac{1,653,417}{2,408,204}$ = .69 = 144 = 44%	$\frac{834,238}{800,528}$ = 1.04 = 122 = 22%
1973	$\frac{1,558,315}{2,874,564}$ = .54 = 113 = 13%	$\frac{959,712}{953,265}$ = 1.01 = 119 = 19%
	CUMULATIVE TOTAL = 338%	CUMULATIVE TOTAL = 124%
	Aver/Year =37.6%	Aver/Year =13.8%

Exhibit #21

TOTAL FACTORS PRODUCTIVITY INDEXES

CONSTANT DOLLARS

Year	Motor Vehicle Manufacturers		Motor Vehicle Parts and Accessories Manufacturers	
	Productivity Ratios	Productivity Index (%)	Productivity Ratios	Productivity Index (%)
1964	1.550	Base Year	1.884	Base Year
1965	1.640	5.8	1.868	(-.8)
1966	1.662	7.2	1.913	1.5
1967	1.856	19.7	1.954	3.7
1968	1.781	14.9	1.924	2.1
1969	1.776	14.6	2.047	8.7
1970	1.686	8.8	1.941	3.0
1971	1.757	13.4	2.020	7.2
1972	1.799	16.1	2.044	8.5
1973	1.772	14.3	2.016	7.0
Cumm. Total		115.8%		40.9 %
Avg. per Yr		12.9%		4.54%

C. Productivity Trend Analyses

The main cause of the productivity growth in the Canadian automotive macroeconomic sector is the signing of the Canada - United States Automotive Products Trade Agreement of 1965 (A.P.T.A.) with the purpose of improving trade imbalance with the United States by reducing imports or increasing exports using whatever means were available and necessary. This Agreement has fostered an accumulation of technical knowledge, investment in new methods of production, and the education and training of workers and managers which have raised productivity in the automotive industry of Canada. A necessary condition for the effective use of these resources and an increasing rate of productivity growth is an expanded North American market and an expanding economy with high employment and optimum utilization of manufacturing and assembly plants and machines.

Significant productivity gains have been made through the cooperation of the Canadian and the United States governments, motor vehicle corporate managements and organized labour.

Productivity growth vastly differs between the two sub-sectors of the Canadian automotive industrial sector over both the short and the long term. The short term is influenced by the effects of changes in the business cycle because productive capacity, including the work force, is not so flexible that manufacturers can adjust it immediately to changes in consumer demands. The long term is basically affected by by changes in the input factors underlying productivity improvements, such as increased availability of capital, improvements in the quality of labour, advances in technology, allocation of resources, increased economies of scale, and advances in managerial expertise.

The Motor Vehicle Manufacturers Sub-Sector

The total factors productivity trend for the Motor Vehicle Manufacturers Sub-sector comprising between 18 to 22 members shows significant productivity growth during the first three years of the life of the agreement and thereafter as indicated by the productivity index and trend analyses (Exhibits #21 and #22). The average improvement in the productivity rate has been 12.9 per cent per year over the span of nine years.

The Motor Vehicle Manufacturers alone invested $533 million[20] in new modern assembly and parts manufacturing facilities to satisfy legal commitments undertaken by the automotive corporations. Labour content in this highly capital-intensive industry was drastically reduced and the ratio of total output to the total labour input changed significantly to account for the rapidly increasing productivity growth as expressed by the productivity index and trend analyses graph (Exhibits #21 and #22).

The Parts and Accessories Manufacturers Sub-Sector

Productivity growth in this sub-sector has been relatively slower as indicated by the productivity index and trend analysis graph (Exhibits #21 and #22), due to its structure and the competitive position in the Canadian market as well as the United States market. As indicated in Table #2, there have been between 154 and 229 Parts and Accessories Manufacturers to share about 36 per cent of the volume of output compared to Motor Vehicle Manufacturers. Since consumer demand for parts and accessories manufactured in Canada is small, it is not possible to draw a meaningful comparison of productive efficiencies and productivity growth between Parts and Accessories Manufacturers and the giant automotive corporations and/or United States parts and accessories suppliers.

Parts and Accessories Manufacturing sub-sector is relatively affected by the Original Equipment Manufacturers (O.E.M.) and after market demand by numerous parts and accessories dealers; car, truck and bus dealers; independent service garages; etc. The biggest expectation for a huge United States parts and accessories market, however, has not yet materialized, which is in reality a failure to fully implement the Automotive Products Trade Agreement of 1965.

The total factors productivity trend for the Motor Vehicle Parts and Accessories Manufacturers sub-sector shows a decline (Exhibit #21) in productivity to the point of (-0.8%) in 1965 due to the reorganization and restructuring of both the Motor Vehicle Manufacturing Industry and their own manufacturing facilities. As indicated by the trend analysis graph (Exhibit #22), the productivity growth gained steady by rather sluggish.

improvement over the span of subsequent eight years averaging 4.5 per cent per year.

Another valid reason for this industry to have slow productivity growth is that it comprises a large number of small companies with low volume of production and inadequately automated manufacturing and assembly facilities. As a sub-sector it can not economically compete or expect to attain productivity growth equal to Motor Vehicle sub-sector with the huge volume of production facilities and superior capital investment availability.

Total Labour Input: Productivity trend of this input has shown rapid and continuous improvement in productivity growth as indicated by the productivity index and trend analysis graph(Exhibits #21 and #24). Total Labour Input of both sub-sectors is analysed here as a singular input in relation to the total output, therefore, it is shown in much more favourable light that the total factors input.

Motor Vehicle Manufacturers Total Labour Input gained very little productivity growth during the first two years of the life of the agreement due to industry adjustment to a new environment. Productivity growth as contributed by the Labour Input gained its momentum in 1967 and has steadily continued ever since. The underlying reason behind this rapid productivity growth is that the industry became highly capital intensive, highly automated and more centralized with parent automotive companies in the United States.

Motor Vehicle Parts and Accessories Total Labour Input initially contributed to the productivity growth in 1966 and has constantly been increasing ever since as indicated by the productivity index and trend analysis graph (Exhibits #21 and #24) Productivity growth, though, began increasing one year sooner, has not reached as high as the labour input of Motor Vehicle sub-sector.

The Parts and Accessories sub-sector is not as capital intensive as the Motor Vehicle sub-sector and there are many small or very small parts manufacturers in this group. However, total labour input of this sub-sector has made, as a singular input, a significant contribution to productivity growth during the decade.

Fuel and Electricity Input: Productivity trend of this input has shown a rapid and continuous improvement in productivity growth particularly in the Motor Vehicle Manufacturing sub-sector as indicated by the productivity index and trend analysis graph (Exhibits #23 and #25). Fuel and Electricity input is being analysed as a singular input in relation to the total output of the automotive industry sector. This factor input is judged on its own merit in the context of productivity level whether it is an improvement or decline.

Motor Vehicle Manufacturers Fuel and Electricity input had shown a slight productivity increase of 7.43 per cent per year in 1965 and the following two years gained lesser rate of increase that 1965. Actual productivity gained rapid increase in 1968 and 1969 consecutively and at a slower pace thereafter. Reorganization and restructuring of this sub-sector was accomplished in 1968 and Motor Vehicle industry was able to negotiate and obtain much more favourable cost rates from the utilities, coal mining companies, and the fuel oil and gasoline suppliers to better utilize newer fuel and electricity consuming facilities with more emphasis on economy and efficiency.

Parts and accessories manufacturers fuel and electricity input had experienced a declining trend in the productivity level during the first three years of the life of the agreement as indicated by the productivity index and trend analysis graph (Exhibits #23 and #25). However, in 1963, the productivity level began to slightly improve and steadily gained productivity growth for the subsequent six years.

The underlying reason or reasons behind the initial decline in the factor productivity is that this industry with many small manufacturers was unable to secure favourable enough volume discount rates from the energy suppliers during the years of reorganization and restructuring of this sub-sector of the automotive industry sector. Small parts and accessories manufacturers do not have efficient energy consuming and controlling facilities and, therefore, there is liable to be unwarranted waste and misuse of the energy input.

Materials and Supplies Input: Productivity trend of this input factor shows that a gradual productivity growth has been experienced as indicated by both the productivity index and the trend analysis graph (Exhibits #21 and #26).

This input factor comprises quantities and laid down cost values of materials, supplies and purchased components owned and used during the year in manufacturing activities and related processes. Included in this group are maintenance and repair supplies not chargeable to fixed assets accounts and any amounts charged by other suppliers for work done on materials owned by the automotive manufacturer.

Motor Vehicle Manufacturers sub-sector productivity trend indicates a constant increase in productivity until it reaches 1972. At this point, there is a definite decline by 5.36 per cent per year in the productivity level. Since this factor input comprises a multitide of activities that may contribute to a sudden cost increase without prior budgeting for it or a shortage of a kind of material that may have to be substituted by other, more expensive material. A supplier may go out of business and an automotive company is forced to transfer its requirements to another supplier and pay a premium price for a few months of the model year to maintain production and/or assembly output.

Parts and accessories manufacturers sub-sector displays its steady productivity growth for the entire span of nine years. This sub-sector being smaller and more flexible in changing their suppliers, has not had any experience that might have contributed to a decline.

Total Assets Input: Productivity trend of the subject input has shown rapid and rather unusual decline in productivity level as indicated by the productivity index and trend analysis graph (Exhibits #17 and #27).

Total assets comprise the total resources which automotive industry sector owns, such as land used for sites of manufacturing activities, office buildings, plants, power houses and facilities, machinery, equipment, unoccupied land planned for future development of manufacturing and assembly facilities, patents, unexpired insurance, durable inventory, goods-in-process inventory, notes receivables, accounts receivable, cash, etc. When total assets are included as an input in the productivity measurements, it is obvious that productivity level is lowered in proportion to the industry sector's total assets intensity and that total assets productivity trends are to be inversely correlated with labour productivity.

Included in the total assets aggregate are many highly valued components such as unoccupied land, office buildings, etc., that immediately do not contribute to productivity and, therefore, indicate on the trend analysis graph (Exhibit #27) a negative effect on the productivity level.

Value-added per Employee: Productivity trend of the Value Added concept illustrates that a very rapid productivity growth has been gained for the duration of nine years as indicated by both the productivity index and trend analysis graph (Exhibits #18 and #28).

The type of automotive parts that are being manufactured makes a significant impact on total labour productivity when measured in terms of value-added per employee. The value-added per employee in general increases in relation to the level of capital intensity of the automotive manufacturing industry. As indicated by the productivity trend analysis graph, the value-added per employee in the Motor Vehicle Manufacturing sub-sector is substantially higher than the value-added per employee in the Parts and Accessories Manufacturing sub-sector. This is due to the fact that Motor Vehicle Manufacturing industry uses heavy machinery and equipment for the manufacture of engines, transmissions, large stampings, etc., which are highly capital intensive. A comparison of productivity growth on the basis of value-added per employee shows that the productivity growth in the Canadian Motor Vehicle Manufacturing Industry will remain higher than that in the Motor Vehicle Parts and Accessories Industry for the same compelling reason of capital intensity.

Value-Added per Materials and Supplies Input: Productivity trend analysis of this concept vividly indicates that the productivity level has drastically increased in the Motor Vehicle Manufacturing sub-sector, however, it has not followed the same pattern in the case of parts and accessories manufacturing sub-sector as indicated by the productivity index and trend analysis graph(Exhibits #20 and #29).

It follows the same explanation that Motor Vehicle Manufacturing sub-sector is much more capital intensive than Parts and Accessories sub-sector and the rate of productivity growth of the value-added per factor input in the former is much higher than in the latter.

The average rate of productivity growth of the value added per factor input is 37.6 per cent per year for the Motor Vehicle Manufacturers and 13.8 per cent per year for the Parts and Accessories industry.

A comparison of productivity growth of the value-added per material and supplies input indicates (Exhibit #29) that the productivity growth in the Parts and Accessories industry will always remain lower due to its lower capital intensity.

Value-Added per Fuel and Electricity Input: The productivity trend of the fuel and electricity input, as expressed in terms of value-added, has shown a quick and constant increase in productivity growth specifically in the Motor Vehicle Manufacturers sub-sector as indicated by the productivity index and trend analysis graph (Exhibits #19 and #30) However, the Parts and Accessories sub-sector showed a declining trend of the productivity level during first three years of the life of the agreement (Exhibits #19 and #30). During subsequent years productivity level has shown constantly increasing trend. However, its performance was only 12.6 per cent per year comparing with the Motor Vehicle Manufacturers' increase of 33.8 per cent per year.

The underlying reason for such a vast difference in the productivity growth between the two sub-sectors is, again, the Motor Vehicle Manufacturing industry is highly capital intensive and the Parts and Accessories Manufacturers lack that capital intensity.

EXHIBIT # 22

TOTAL FACTORS PRODUCTIVITY TREND ANALYSIS

Motor Vehicle Manufacturers ———

Parts and Accessories Manufacturers - - - - -

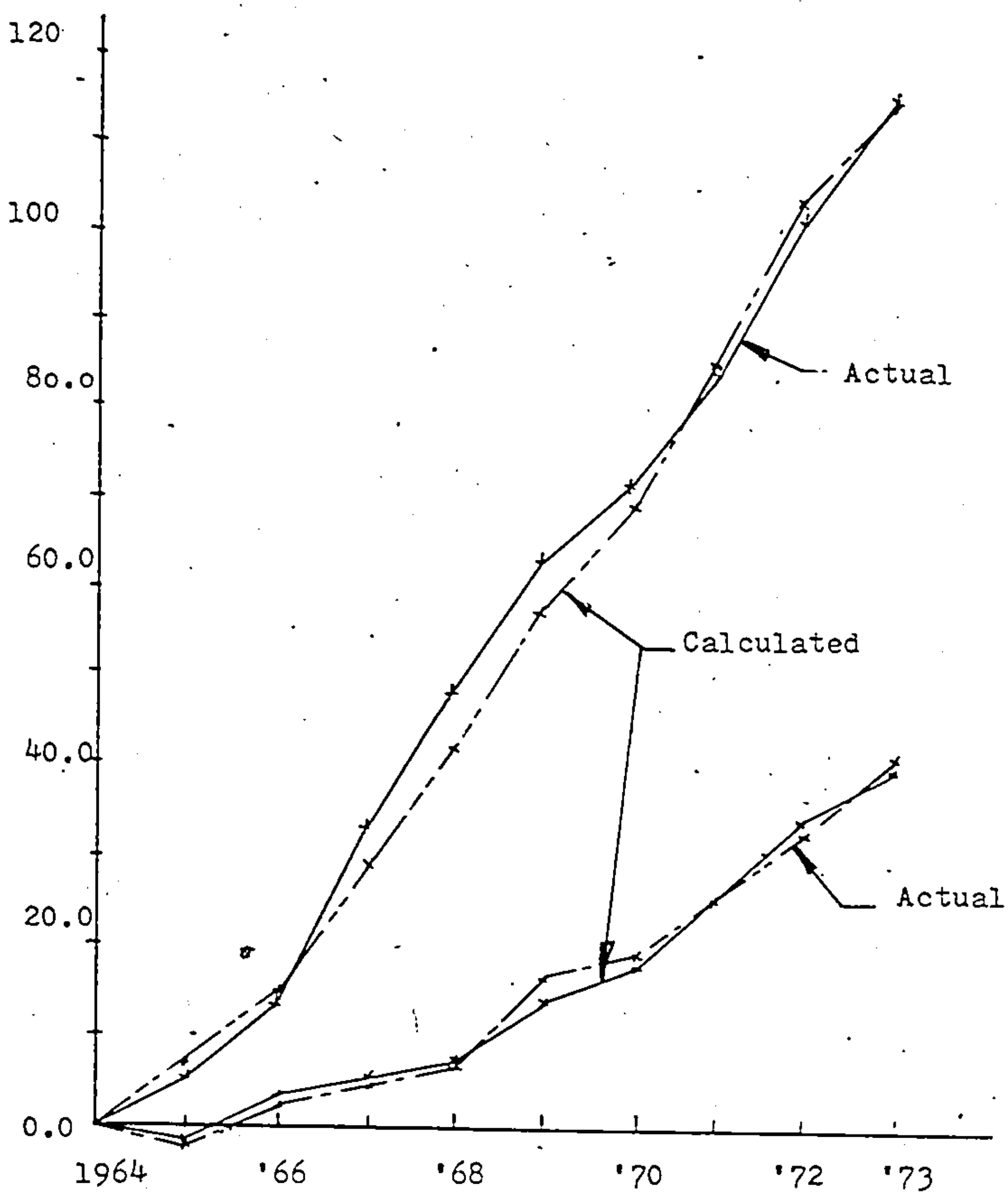


EXHIBIT #23

PARTIAL FACTOR PRODUCTIVITY INDEXES

Fuel and Electricity, Material Supplies and Total Labour

Constant Dollars

Year	Motor Vehicle Manufacturers			Motor Vehicle Parts and Accessories Manufacturers		
	Fuel and Electricity Index	Material and Supplies Index	Total Labour Index	Fuel and Electricity Index	Material and Supplies Index	Total Labour Index
1964	Base Year	---	---	---	---	---
1965	7.43%	4.09%	.71%	-.54%	3.85%	4.21%
1966	1.87	4.97	3.47	-5.55	3.78	14.66
1967	6.67	12.32	21.40	-7.57	7.42	25.72
1968	15.20	8.07	32.02	3.48	6.45	18.21
1969	24.13	9.62	44.06	20.47	9.02	22.69
1970	9.74	3.88	24.96	8.75	5.46	13.84
1971	15.09	4.98	30.41	13.37	12.04	21.89
1972	14.93	4.02	23.54	13.37	12.14	24.72
1973	17.05	-5.36	15.09	18.56	9.81	28.34
Cumm. Total	112.11%	46.49%	195.66%	64.32%	69.47%	174.28%
Aver/Year	12.46%	5.17%	21.74%	7.15%	7.77%	19.36%

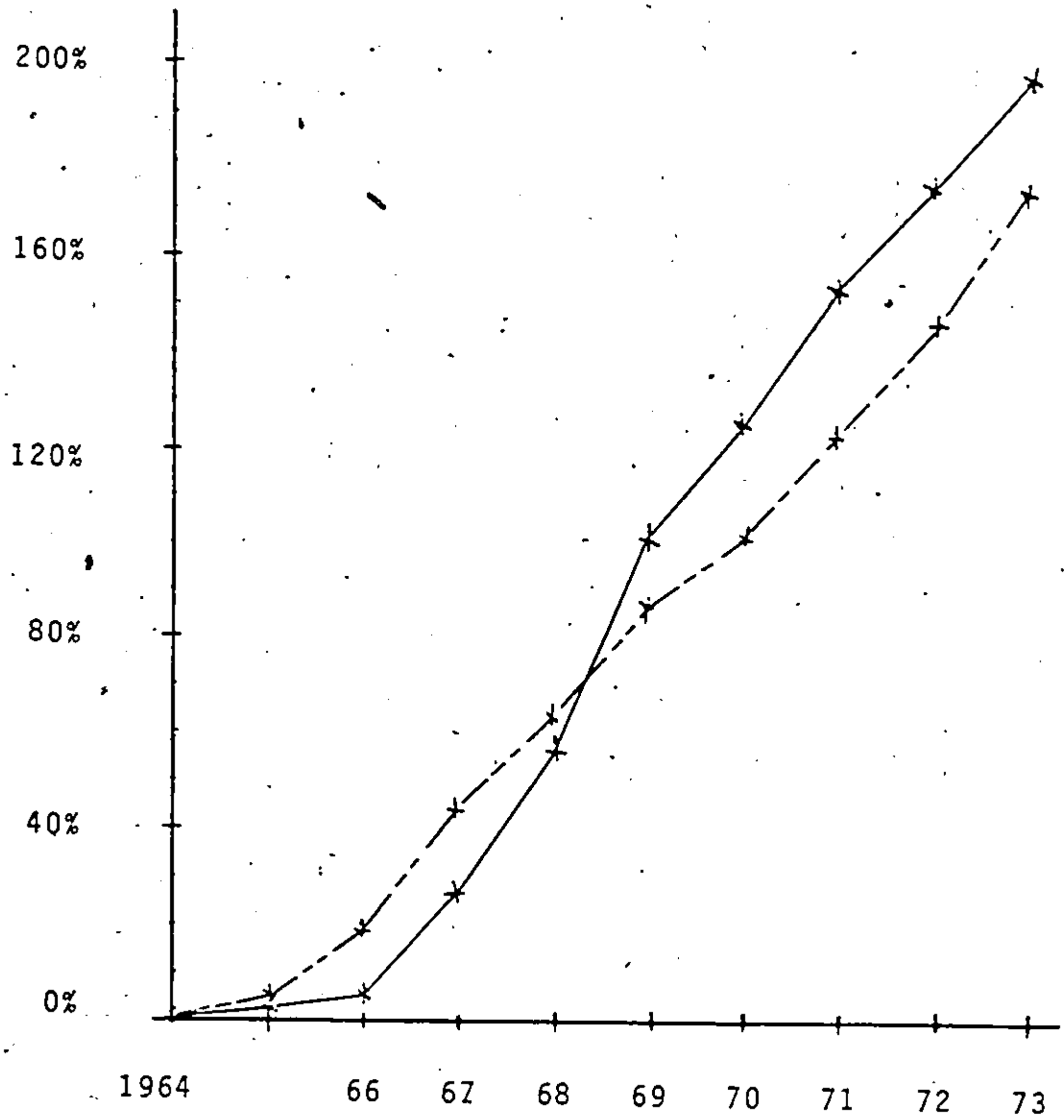
EXHIBIT #24

PARTIAL FACTOR PRODUCTIVITY TREND ANALYSIS

(TOTAL LABOUR)

MOTOR VEHICLE MANUFACTURERS ____________

PARTS AND ACCESSORIES MANUFACTURERS — — — —



PARTIAL FACTOR PRODUCTIVITY TREND ANALYSIS

(FUEL AND ELECTRICITY)

MOTOR VEHICLE MANUFACTURERS ————

PARTS AND ACCESSORIES MANUFACTURERS — — — —

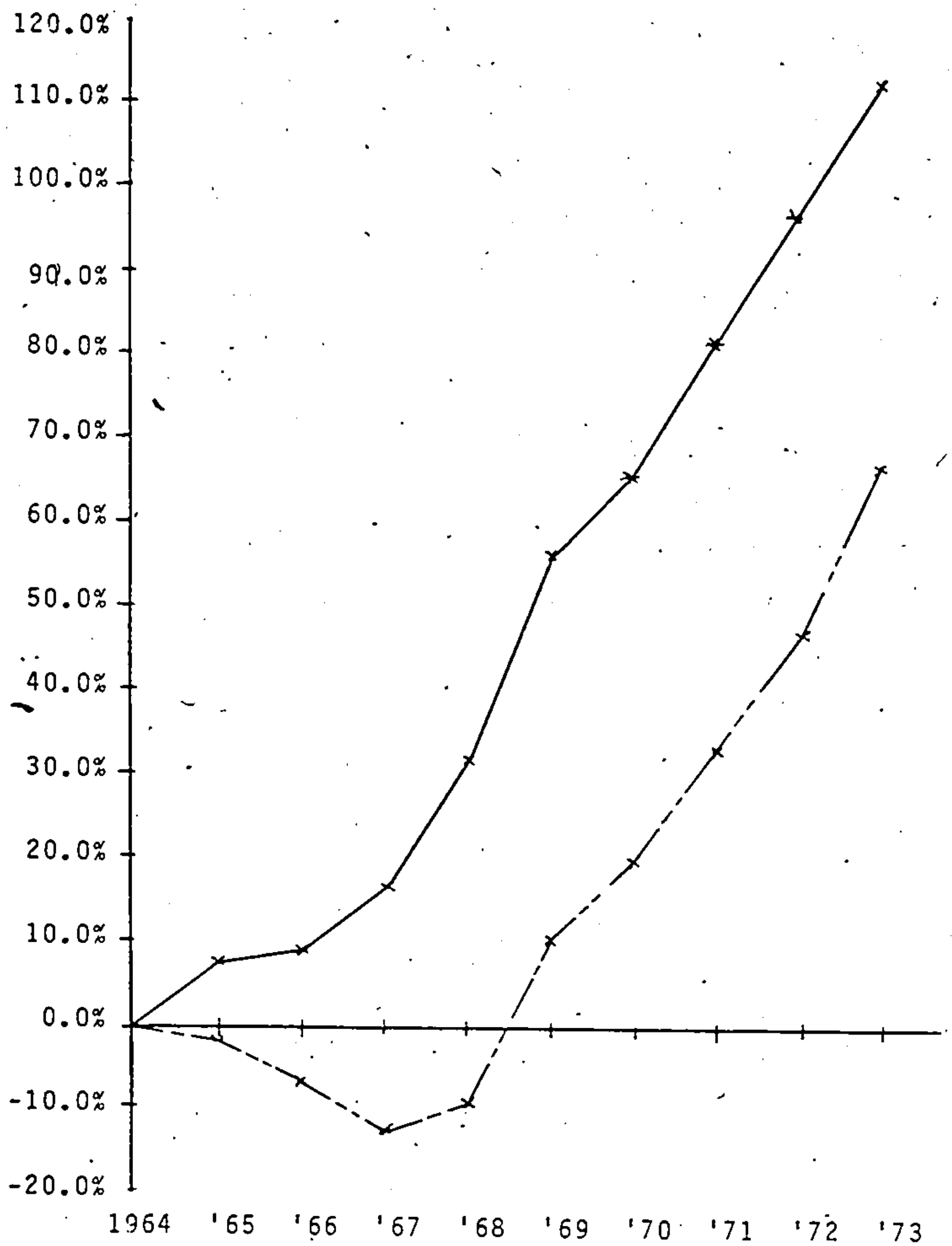


EXHIBIT #26

PARTIAL FACTOR PRODUCTIVITY TREND ANALYSIS

(MATERIALS AND SUPPLIES)

MOTOR VEHICLE MANUFACTURERS ________

PARTS AND ACCESSORIES MANUFACTURERS ___ - - ___

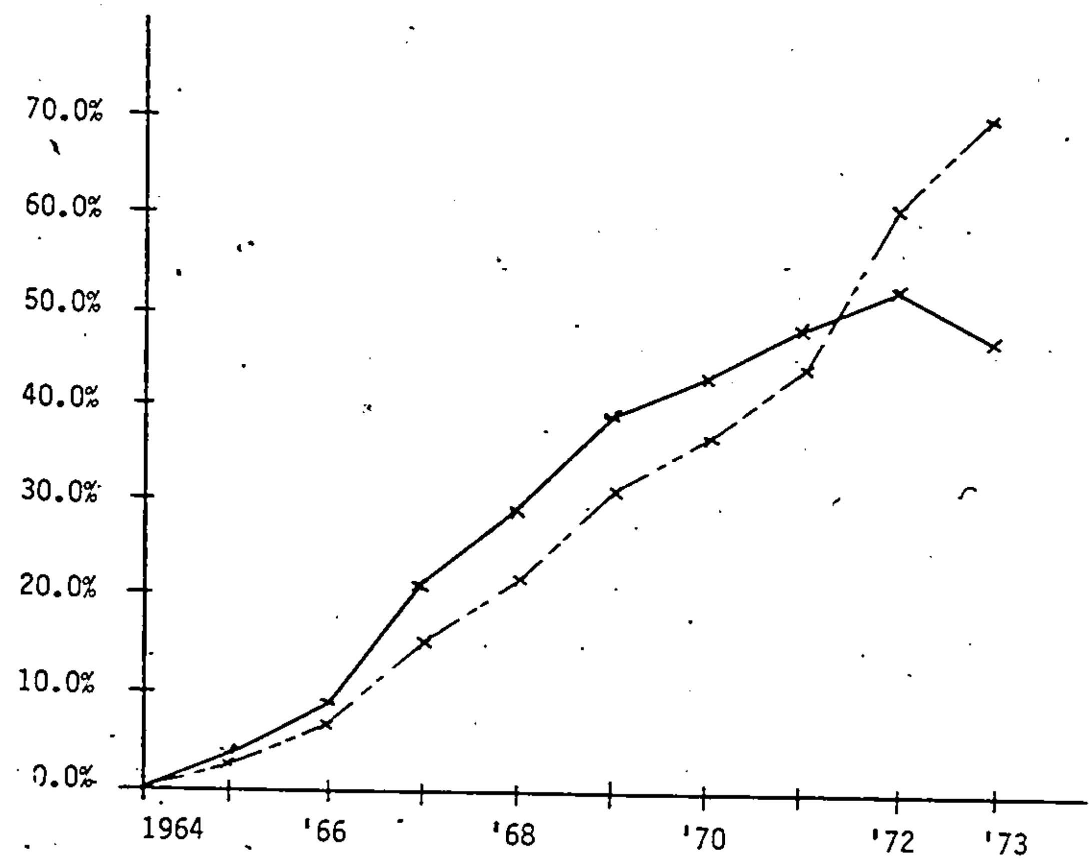


EXHIBIT #27

PARTIAL FACTOR PRODUCTIVITY TREND ANALYSIS

(TOTAL ASSETS)

COMBINED MOTOR VEHICLE AND

PARTS AND ACCESSORIES MANUFACTURERS

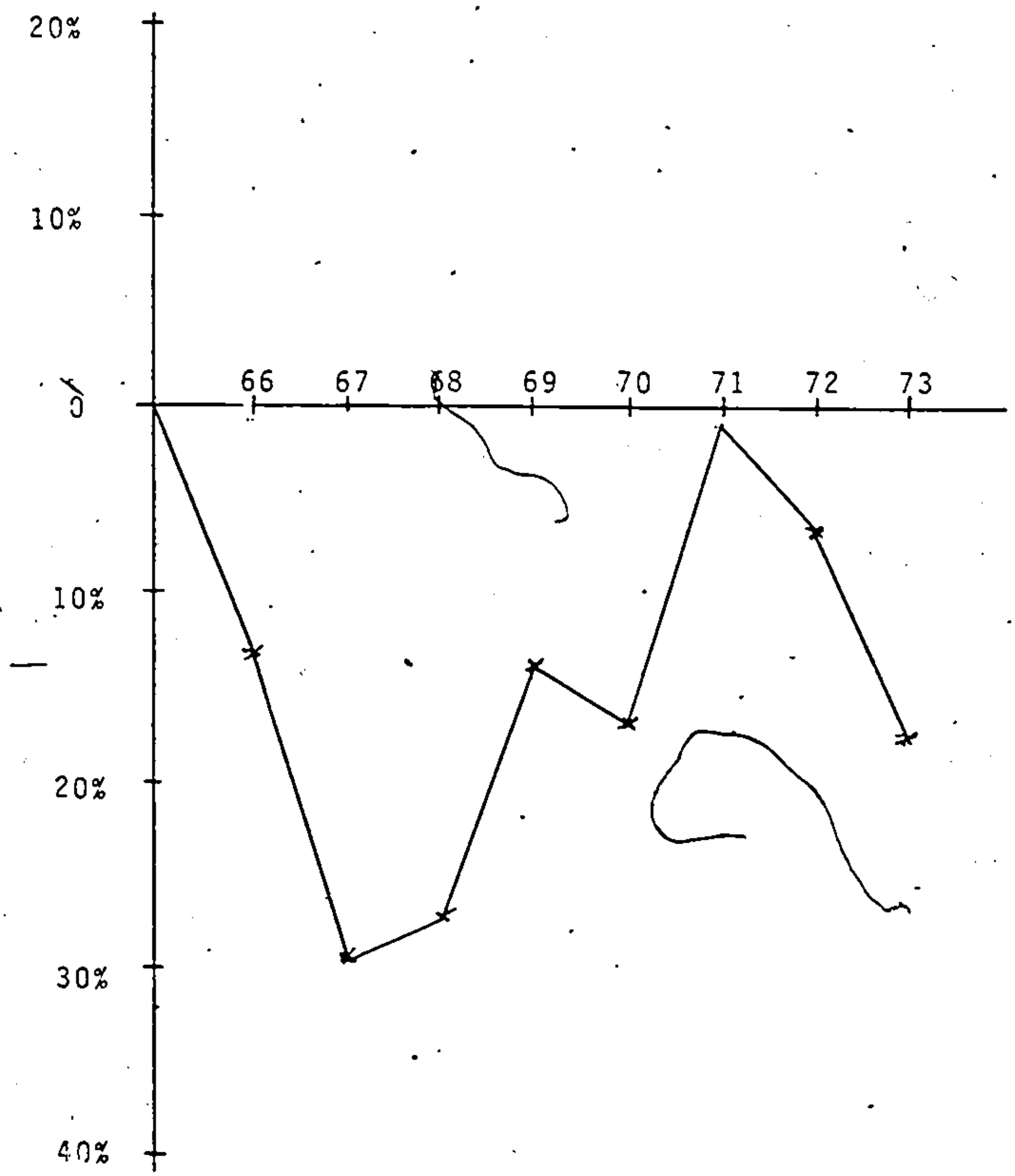


EXHIBIT #28

PRODUCTIVITY TREND ANALYSIS OF VALUE-ADDED PER EMPLOYEE

MOTOR VEHICLE MANUFACTURERS ————

PARTS AND ACCESSORIES MANUFACTURERS — — —

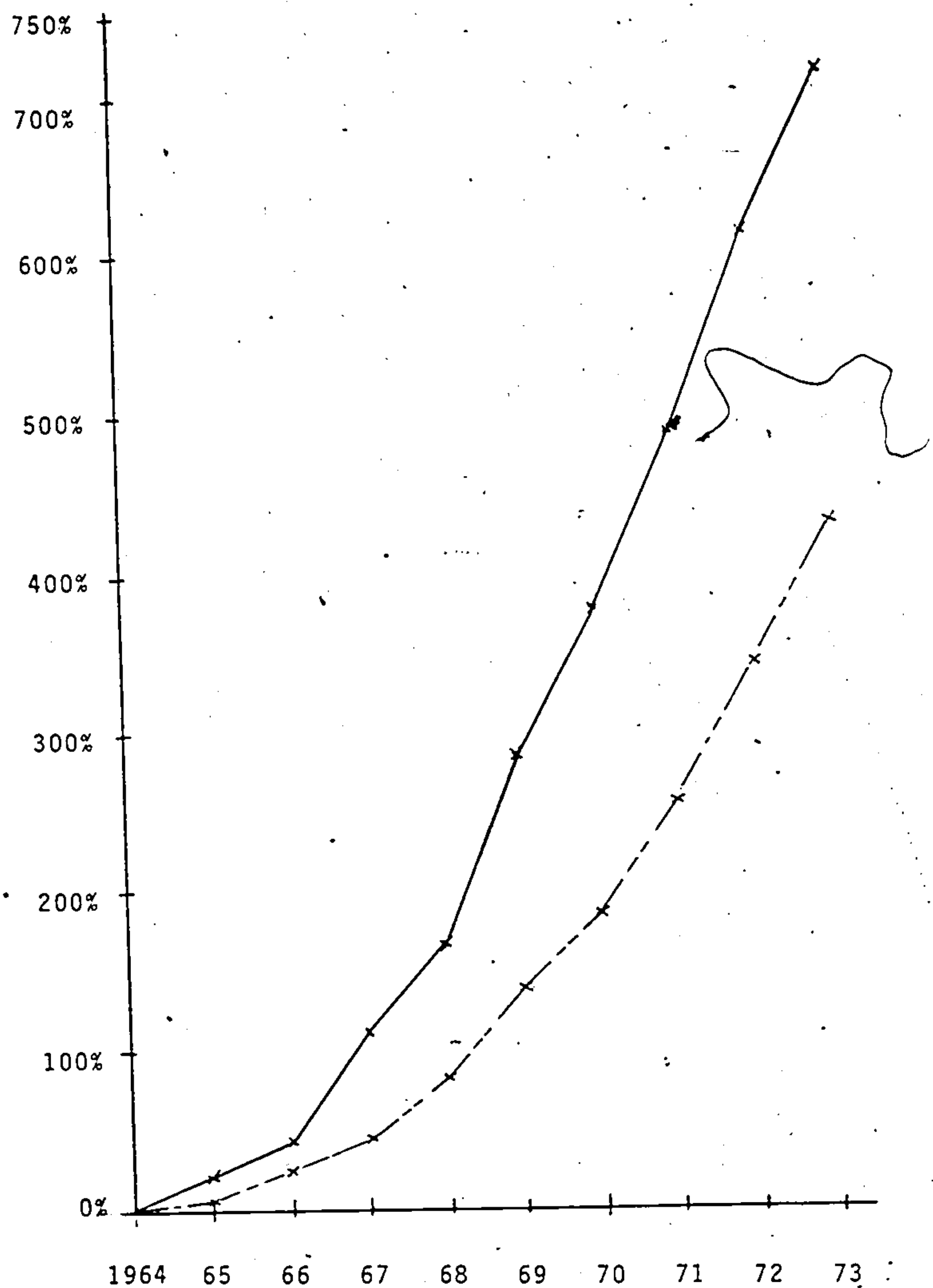


EXHIBIT #29

PRODUCTIVITY TREND ANALYSIS OF VALUE-ADDED
PER MATERIALS AND SUPPLIES INPUT

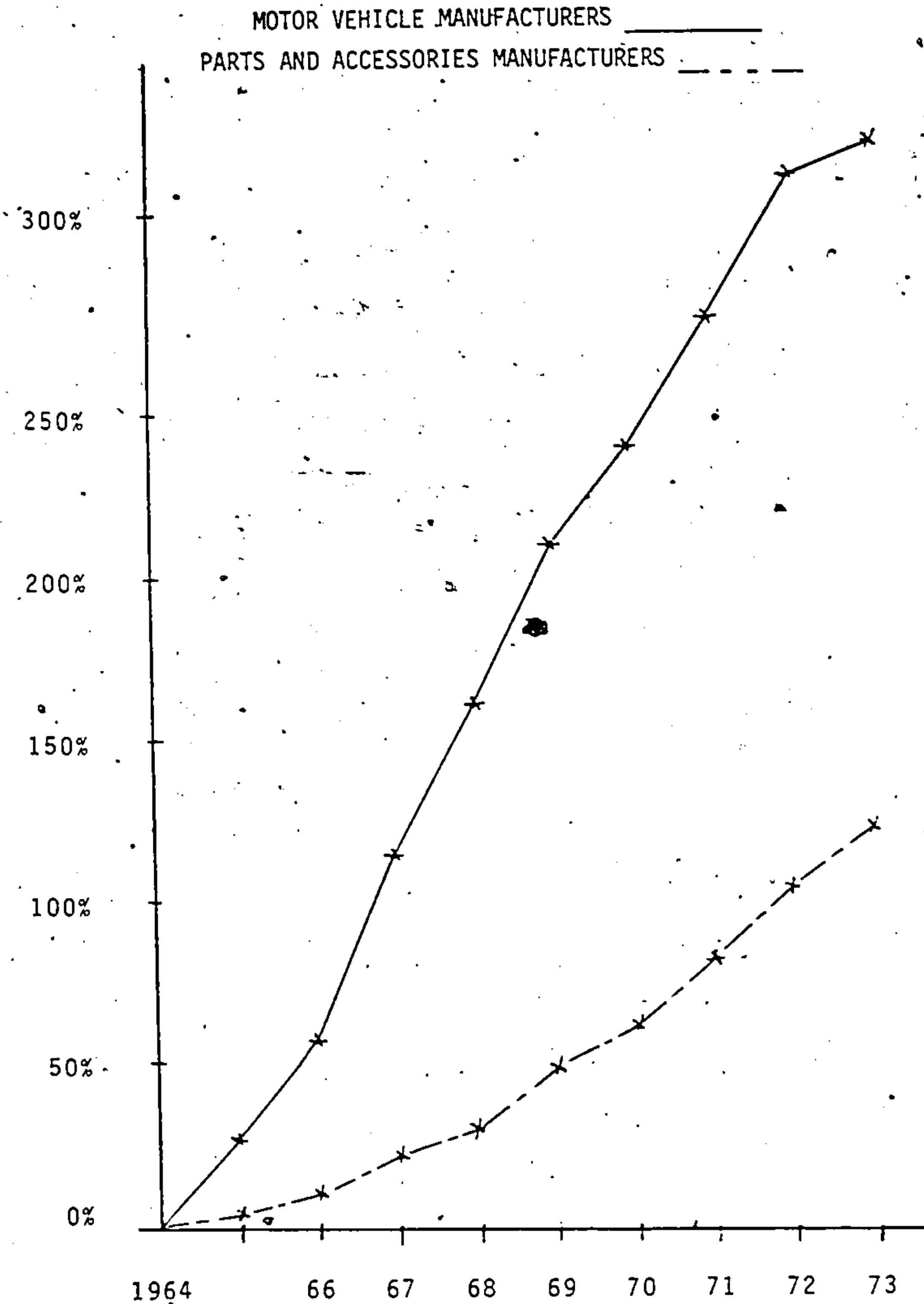


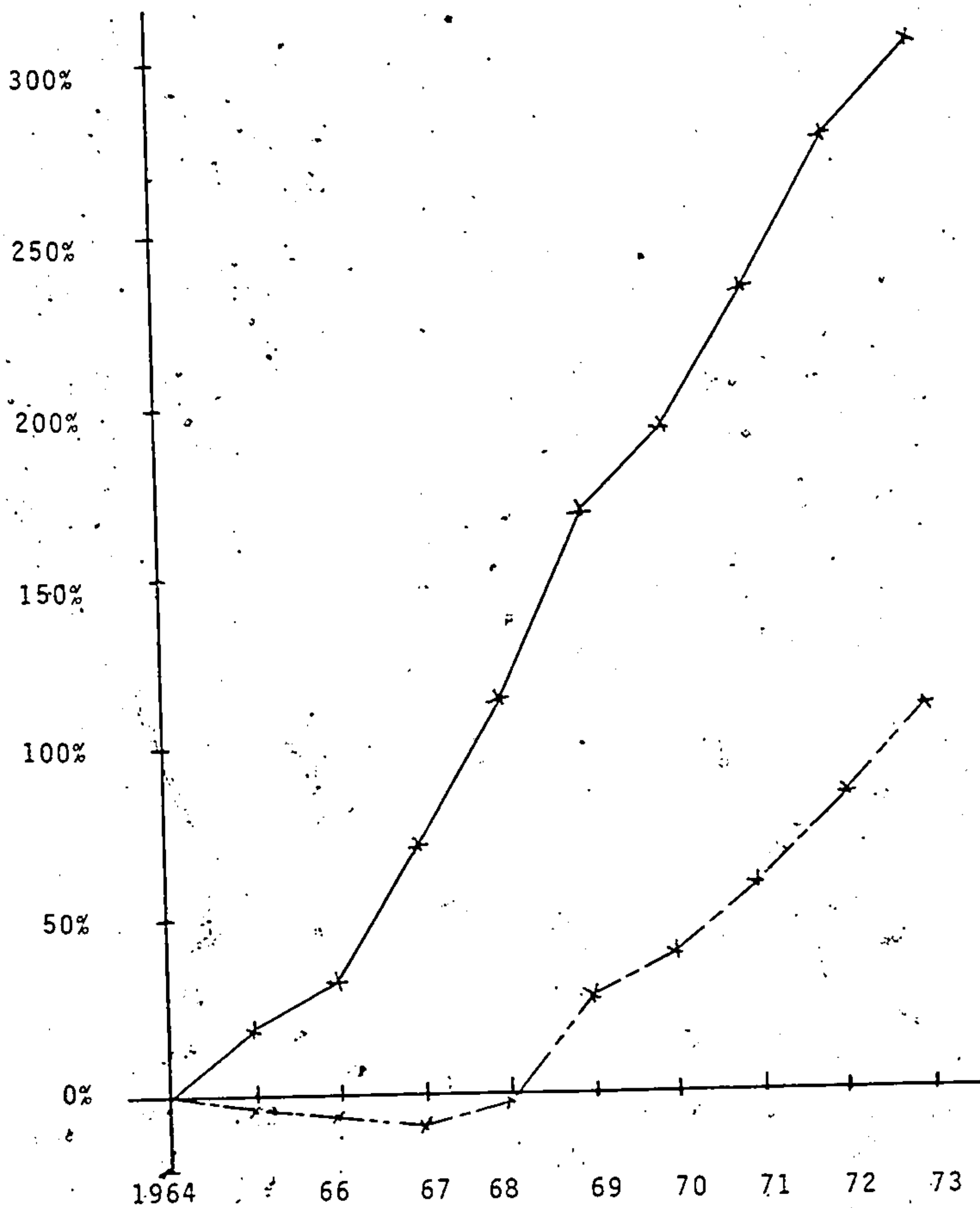
EXHIBIT #30

PRODUCTIVITY TREND ANALYSIS OF

VALUE-ADDED PER FUEL AND ELECTRICITY INPUT

MOTOR VEHICLE MANUFACTURERS ————

PARTS AND ACCESSORIES MANUFACTURERS — — — —



D. Multiple Regression Application

Multiple regression analysis is a method by which the relationship between all the variables is simultaneously taken into account when two or more independent variables are to be used in obtaining estimates of the dependent variable.

In multiple regression analysis, the regression model is described as the path of the means of the dependent variable Y for all combinations of X_1, X_2, $\ldots X_{p-1}$. Assume that the path of the means of Y takes the form:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \varepsilon_i$$

Which is a multiple regression model with four independent variables to be used for the computation of productivity indexes utilizing empirical data in the automotive industry sector.

Motor Vehicle Manufacturers data of partial factor inputs: fuel and electricity, materials and supplies and total labour, total outputs, and productivity index were set up according to the multiple regression model and programmed for the computer using "Multfit" programme to compute the variables for nine years. The computer print-out provides calculated productivity index (Variable Y_i),a difference between actual and calculated data, percentage difference, regression coefficient, mean values, standard deviation, standard deviation of residuals and the coefficient (index) of determination as shown on the Exhibit #31.

A criterion for the evaluation of the "goodness of fit" of a regression relationship is the coefficient of multiple determination. It is the proportion of the total variability in the data set which may be illustrated by a regression surface.

The coefficient of multiple determination, R^2, can be expressed as the ratio of the explained variation and the total variation of Y, or as one minus the ratio of the residual or unexplained variation and the total variation of Y_1. The maximum value of R^2 is one when Σe^2 is zero. The coefficient of multiple determination of one indicates that the dependent variable surface provides a perfect fit for the data and explains 100 per cent of the variability. A coefficient of multiple determination of zero indicates that the regression surface does no better than using the mean of Y_i; that is, it explains zero per cent of the variability.

The computer print-out for the Motor Vehicle Manufacturers sub-sector shows that the coefficient of multiple determination is 54.7 per cent which is far from one and, therefore, far from being a perfect fit on the regression surface. In this case, the coefficient of multiple determination is successful in explaining 54.70 per cent of the total variation in the productivity index, Y_1, associated with the use of the total factor input and output variables, X_1, X_2, X_3 and X_4.

The computer print-out for the Motor Vehicle Parts and Accessories sub-sector indicates that the coefficient of multiple determination is 94.9 per cent which is much closer to a perfect fit on the regression surface. In this case, the coefficient of multiple determination is successful in explaining 94.90 per cent of the total variation in the productivity index Y associated with the use of the input and output variables X_1, X_2, X_3 and X_4 shown on the Exhibit #32.

1.) Multiple Regression Model as a Prediction Tool

The principal purpose of the multiple regression analysis is to incorporate the empirical data of the input factors (fuel and electricity, materials and supplies, and total labour(Exhibit #6), and the total output (Exhibit #3) as independent variables into a model which will result in the improved computation of the dependent variable.

In the multiple regression model, productivity growth is affected by a large number of factors, such as the quality and motives of management and labour, the state and application of technology, the availability of capital, economies of scale, materials and supplies, fuel and electricity as well as market fluctuations. However, the most significant contribution to productivity growth is attributed to the quantifiable input factors already cited which are being evaluated below.

a) Fuel and Electricity Factor Input: Energy consuming process has a very significant influence upon productivity growth. The energy supply is international in scope, since most of the oil purchased abroad is for Eastern Canada, therefore, the cost of oil supplies varies with the unpredictible mood and climate of internation cartel economics and trade in the Middle East and the South American countries. Stable prices of oil supply will ensure the automotive industry sector of more predictible productivity growth as far as this factor input is concerned. The automotive industry sector will have to decrease its dependance upon oil supplies from abroad by returning to coal burning of North American coal supplies thus ensuring more predictible cost of the vital input factor in the productivity growth.

Natural gas is another very important factor for the energy consuming automotive industry of Eastern Canada. However, major bulk of natural gas is of domestic supply and, therefore, the cost of it is more reliably predictible for immediate and distant future. Federal Government mutually with provincial government have jurisdiction over the supply of gas, therefore, no erratic price fluctuations are expected that may have a considerable influence on the future of the manufacture and assembly of the automotive products and hence productivity growth.

Electricity supply is very extensively utilized in the manufacture and assembly of the automotive products. Its contribution to the total production system is extremely important in many ways, however, this source of energy is of domestic and provincial generation and supply. The stability in supply and the cost of it is positively assured for many years to come without any drastic interruptions. Automotive corporations will be able to make long-range planning as far as the utilization of electricity is concerned for the future years.

b) Materials and Supplies Factor Input: This factor input is the most diversified of the major three factors. It comprises quantities and laid down cost values of materials, supplies and pruchased components owned and used during the year in manufacturing activities and related processes. Since this factor input encompasses a multitude of activities that may contribute to an unexpected cost increase without prior budgeting for it or a shortage of a kind of material that may have to be substituted by other more expensive variety, it is very difficult to provide definite, predictible future for this factor. This factor input will fluctuate with the economic conditions of the country and it will continue to be the least controllable of the three factor inputs.

c) <u>Total Labour Factor Input</u>: This category of factor input comprised both production and related workers and administrative and office employees. Their contribution to productive processes is expressed in terms of constant dollars.

Human resources managements is each corporation are continuously engaged in the short-term and a long-term planning of manpower requirements in both hourly or salaried categories. An accurate forecast can be made of future needs by a careful analysis of the past relating it, statistically, to economic forecasts. Therefore, automotive industry sector is capable of planning and controlling manpower requirements.

Multiple regression model may be used as a prediction tool to project into the future years but with caution. The estimates or predictions outside the scope of the model may not be appropriate once they are extended outside the region of the observations. In multiple regression, it is particularly easy to lose track of this region since the levels of $X_1 \cdots \cdots X_{p-1}$ jointly define the region. An individual range of each independent variable cannot define the region of observations, it must consist of two or more independent variable ranges. The farther away the individual ranges of independent variables extend from the region of observation, or from the actual data obtained, the less correlation remains between them. As a result, prediction becomes less reliable for that particular year of for subsequent years.

EXHIBIT #31

MULTIPLE REGRESSION MODEL PRODUCTIVITY INDEX

(MOTOR VEHICLE MFRS)

MULFIT

DO YOU WANT INSTRUCTIONS (0=NO, 1=YES).... WHICH ?0
N, P, S, D = 79,5,0,0

IN 761 EXP OVERFLOW

IN 761 EXP OVERFLOW

IN 761 EXP UNDERFLOW

M U L T I V A R I A T E   C U R V E   F I T

VARIABLE	REGR COEFF	MEAN VALUE	STD DEV
1 (CONSTANT =	-17.46655)	12.75556	4.283071
2	1.57867e-05	3036800	641959.9
3	.0045156	10052.67	1735.416
4	-3.51448e-05	1950961	479427.8
5	1.67475e-05	325620.2	60501.79

STANDARD DEVIATION OF RESIDUALS = 2.99163
INDEX OF DETERMINATION (R-SQ) = .5473466
ZERO-CHECK ON MEAN RESIDUAL = 2.03305e-07

A C T U A L   V S   C A L C U L A T E D

ACTUAL Y	CALCULATED $\hat{Y}$	DIFFERENCE $\hat{Y}-Y$	PCT DIFFER
5.8	7.362913	1.562913	21.2
7.2	8.812689	1.612689	18.2
19.7	13.38932	-6.310677	-47.1
14.9	13.108	-1.792	-13.6
14.6	14.89477	.2947706	1.9
8.8	11.75372	2.953723	25.1
13.4	15.87565	2.47565	15.5
16.1	18.03149	1.931487	10.9
14.3	11.51545	-2.784552	-24.1

READY

EXHIBIT #32

MULTIPLE REGRESSION MODEL PRODUCTIVITY INDEX

(PARTS AND ACCESSORIES MFRS)

```
MULFIT

DO YOU WANT INSTRUCTIONS (0=NO, 1=YES).... WHICH ?0
 N, R, S, D = ?9,5,0,0

     M U L T I V A R I A T E   C U R V E   F I T

VARIABLE          REGR COEFF        MEAN VALUE       STD DEV

 1 (CONSTANT =    9.547222 )        4.544444         3.21286

          2          9.52599e-05      1204979          372647
         3        -.0017716         12284.11        2954.782
          4         -7.61318e-05     609479.4         175851.6
          5        -.0001963        262991.8          73854

    STANDARD DEVIATION OF RESIDUALS =     .7268317
      INDEX OF DETERMINATION (R-SQ) =     .9498219
       ZERO-CHECK ON MEAN RESIDUAL = -3.24514e-07

     A C T U A L   V S   C A L C U L A T E D

ACTUAL            CALCULATED        DIFFERENCE       PCT DIFFER
          Y                  Ŷ                  Y-Ŷ
         -.8        -.6319259          .1680731    -26.5
         1.5         .9234352         -.5765648    -62.4
         3.7         2.684558         -1.015442    -37.8
         2.1         3.328308          1.228308                36.9
         8.7         8.126244         -.5737565       -7
           3         3.886315          .8863151                22.8
         7.2          7.47512          .2751202                 3.6
         8.5         8.845601          .3456011                 3.9
           7         6.262342         -.737658     -11.7

READY
```

2. Multiple Regression Data And Calculations for the Testing of Hypotheses

(Motor Vehicle Manufacturers)

This Multiple Regression Model comprises five variables: one dependent variable, Y_1 and four independent variables X_1, X_2, X_3, and X_4 resulting in the following equation:

(1) $Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \varepsilon_i$

Hence, the dependent variable ,

Y_i = Productivity index, and the four independent variables:

X_{i1}= Total output

X_{i2}= Fuel and electricity factor input

X_{i3}= Materials and Supplies factor input

X_{i4}= Total Labour factor input, and including the five regression coefficients:

a (constant) = -17.466655

b_1 = 1.57867 E-05

b_2 = 4.5156 E-03

b_3 =-3.51448 E-05

b_4 = 1.67475 E-05

Therefore, the Multiple Regression Model (1) results in the following equation:

$$\hat{Y} = -17.46655 + 1.57867E\text{-}05 \cdot X_{i1} + 4.5156E\text{-}03 \cdot X_{i2} - 3.5448E\text{-}05 \cdot X_{i3} + 1.67475E\text{-}05 \cdot X_{i4}$$

This example typifies a major objective of regression analysis: making predictions. If the type of relation between the variables is known, then knowledge of independent variables will improve the prediction of a dependent variable.

A second major objective of the regression analysis is hypothesis testing. Thus, to provide sufficient data for hypothesis testing, values of the five coefficients a, b_1, b_2, b_3, and b_4 have been determined by the computer "Mulfit" programme [Exhibit #31.]

Since the standard deviation of regression is measured from the mean, which in itself was determined by the least-squares method, it is relatively easy to estimate the standard deviation of regression:

$$S_{y \cdot x} = \sqrt{\frac{\Sigma\ (Y-\hat{Y})^2}{n-5}} \qquad [50]$$

Where $S_{y \cdot x}$ is the estimate of the true standard deviation of regression, $\sigma_{y \cdot x}$, between Y and X.

To construct confidence intervals around the estimated mean, S_b must be used in testing hypothesis.

$$S_b = \frac{S_{y \cdot x}}{\sqrt{\Sigma X^2 \cdot (1-R^2)}}$$

Where S_b is the estimator of a standard deviation σ_b, and R^2 is the coefficient of multiple determination. [Exhibit #31.]

a.) CALCULATION OF $\hat{Y}$

$\hat{Y}$ - predicted Productivity, was computed by the "Mulfit" programme [Exhibit #31.]

b.) REGRESSION DATA AND CALCULATION OF $\Sigma(Y-\hat{Y})^2$

(000 Omitted)

YEAR	X_1	X_2	X_3	X_4	$(Y-\hat{Y})$	$(Y-\hat{Y})^2$
1964	1,673.2	6.27	1,125.7	218.9	0	0
1965	2,130.6	7.43	1,377.3	276.7	1.56	2.43
1966	2,190.5	8.06	1,403.5	276.8	1.61	2.59
1967	2.487.0	8.74	1,489.6	267.8	-6.31	39.82
1968	2.980.3	9.69	1,854.9	295.3	-1.79	3.20
1969	3.453.1	10.42	2,118.7	313.3	.29	.08
1970	2.864.9	9.78	1,854.9	299.8	2.96	8.76
1971	3.457.7	11.26	2,217.0	346.9	2.48	6.15
1972	3.722.8	12.14	2,408.2	394.3	1.98	3.92
1973	4.044.4	12.95	2,874.6	459.5	-2.78	7.73
Σ		90.47	17,599.0	2,930.4		74.68

c.) REGRESSION DATA

YEAR	X_1^2	X_2^2	X_3^2	X_4^2
1964	2.798.9	39.31	1,267,200.5	47,917.2
1965	4.536.9	55.20	1,896,955.3	76,562.9
1966	4.796.1	64.96	1,969,812.3	76,618.24
1967	6.185.2	76.39	2,218,908.2	71,716.8
1968	8.882.2	93.90	3,440,654.0	87,202.1
1969	11.923.2	108.58	4,488,889.7	98,156.9
1970	8.207.7	95.65	3,440,654.0	89,880.0
1971	11.955.7	126.79	4,915,089.0	120,339.6
1972	13.859.2	147.38	5,799,427.2	155,472.5
1973	16.357.2	167.70	8,263,325.2	211,140.3
Σ	89,502.3 x 10^6	975.86 x10^6	37,700,915.4 x10^6	1,724,570.3 x10^6

d.) HYPOTHESIS TESTING

At this point, it is important to determine how far the true rate of change, β is expected to deviate from the estimate of it. Thus it is proper to construct confidence limits around the estimate. In this case, the sample size of 10 is not sufficiently large to utilize the normal distribution and construct 95 per cent limits (± 1.96 standard deviations). However, it can be assumed that the distribution of the dependent variable Y_i to be normally distributed, then the "t" distribution may be utilized. Hence, to construct a 90 per cent confidence interval utilizing the "t" distribution, the following may be used [50].

1. Total Output Hypothesis Testing

R^2 =. 547 (Exhibit #31)

$S_{y.x}$ =4.283 "

$$S_{b_1} = \frac{S_{y \cdot x}}{\sqrt{\Sigma X_1^2 (1-R^2)}}$$

$$= \frac{4.283}{\sqrt{89{,}502.3 \times 10^6 \; (1-.547)}}$$

$$= \frac{4.283}{\sqrt{89{,}502.3 \times 10^6 \; (.453)}}$$

$$= 2.13E-05$$

$$b_1 = 1.58E-05$$

$$b_1 - t_{.05}\, S_{b_1} < \beta_1 < b_1 + t_{.05}\, S_{b_1}$$

$$1.58E-05-(2.015 \times 2.13E-05) < \beta_1 < 1.58E-05+(2.015 \times 2.13E-05)$$

$$1.58E-05-4.29E-05) < \beta_1 < 1.58E-05+ 4.29E-05)$$

$$-2.71E-05 < \beta_1 < 5.87E-05$$

$H_o : \beta_1 = 0$

$H_A : \beta_1 \neq 0$ $\alpha = .05$ (two tailed)

$$t = \frac{b_1 - \beta_1}{S_{b_1}} = \frac{1.58E-05-0}{2.127E-05}$$

$= .743$

Criterion:

For n-5 or five degrees of freedom, at 90 per cent confidence, 5 per cent in each tail, $t_{.05} = 2.015$ and $t_{.025} = 2.571$, reject hypothesis if "t" is greater than 2.571 or less than -2.571.

Thus .743 is less than 2.571 causing the hypothesis not to be rejected. Therefore, the independent variable X_1, total output, does not have a significant effect on the dependent variable Y_i, Productivity.

2.) <u>Fuel and Electricity Factor Input Hypothesis Testing</u>

A 90 per cent confidence interval utilizing the "t" distribution can be constructed as follows:

$$S_{b_2} = \frac{S_{y \cdot x}}{\sqrt{\Sigma X_2^2 (1-R^2)}}$$

$$= \frac{4.283}{\sqrt{975.86 \times 10^6 (1-.547)}}$$

$$= \frac{4.283}{\sqrt{975.86 \times 10^6 \times .453}}$$

$= .204E-03$

$b_2 = 4.52E-03$

$$b_2 - t_{.05} S_{b_2} < \beta_2 < b_2 + t_{.05} S_{b_2}$$

$4.52E-03 - (2.015 \times .204E-03) < \beta_2 < 4.52E-03 + (2.015 \times .204E-03)$

$$4.52E-03 - .411E-03 < \beta_2 < 4.52E-03 + .411E-03$$

$$4.109E-03 < \beta_2 < 4.931E-03$$

$H_0 : \beta_2 = 0$

$H_A : \beta_2 \neq 0 \qquad \alpha = .05$ (two tailed)

$$t = \frac{b_2 - \beta_2}{S_{b_2}} = \frac{4.52E-03-0}{.204E-03}$$

$$= 22.2$$

Criterion:

For n-5 five degrees of freedom at 90 per cent confidence, 5 per cent in each tail, $t_{.05} = 2.015$ and $t_{.025} = 2.571$, reject hypothesis if "t" is greater than 2.571 or less than -2.571.

Thus 22.2 is greater than 2.571 causing the hypothesis to be rejected. Therefore, the independent variable X_2, fuel and electricity factor input, does have a significant effect on the dependent variable Y, Productivity.

3.). <u>Materials and Supplies Factor Input Hypothesis Testing</u>

A 90 per cent confidence interval utilizing the "t" distribution can be constructed in the following manner:

$$S_{b_3} = \frac{S_{y \cdot x}}{\sqrt{\Sigma X_3^2 \; (1-R^2)}}$$

$$= \frac{4.283}{\sqrt{37,700,915.4 \; (1-.547)}}$$

$$= \frac{4.283}{\sqrt{37,700,915.4 \times 10^6 \; (1-.547)}}$$

$$= .104E-05$$

$$b_3 = -3.51E-05$$

$b_3 - t_{.05} S_{b_3} < \beta_3 < b_3 + t_{.05} S_{b_3}$

$-3.51E{-}05 - (2.015 \times .104E{-}05) < \beta_3 < -3.51E{-}05 + (2.015 \times .104E{-}05)$

$-3.51E{-}05 - .210E{-}05 < \beta_3 < -3.51E{-}05 + .210E{-}05$

$-3.72E{-}05 < \beta_3 < -3.30E{-}05$

$H_0 : \beta_3 = 0$

$H_A : \beta_3 \neq 0$ $\alpha = .05$ (two tailed)

$$t = \frac{b_3 - \beta_3}{S_{b_3}} = \frac{-3.51E{-}05-0}{.104E{-}05}$$

$$= -33.75$$

Criterion:

For n-5 or five degrees of freedom at 90 per cent confidence, 5 per cent in each tail $t_{.05} = 2.015$ and $t_{.025} = 2.571$, reject hypothesis if "t" is greater than 2.571 or less than -2.571.

Thus -33.75 is less than -2.571 causing the hypothesis to be rejected. Therefore, the independent variable X_3, materials and supplies factor input, does have a significant effect on the dependent variable Y, Productivity.

4.) Total Labour Factor Input Hypothesis Testing

A 90 per cent confidence interval using the "t" distribution can be constructed as follows:

$$S_{b_4} = \frac{S_{y \cdot x}}{\sqrt{\Sigma X_4^2 \, (1-R^2)}}$$

$$= \frac{4.283}{\sqrt{1,724,570.3 \times 10^6 (1-.547)}}$$

$$= \frac{4.283}{\sqrt{1,724,570.3 \times 10^6 \times .453}}$$

$$= .485E{-}05$$

$b_4 = 1.67E\text{-}05$

$b_4 - t_{.05} S_{b_4} < \beta_4 < b_4 + t_{.05} S_{b_4}$

$1.67E\text{-}05 - (2.015 \times .485E\text{-}05) < \beta_4 < 1.67E\text{-}05 + (2.015 \times .485E\text{-}05)$

$1.67E\text{-}05 - .977E\text{-}05 < \beta_4 < 1.67E\text{-}05 + .977E\text{-}05$

$.693E\text{-}05 < \beta_4 < 2.647E\text{-}05$

$H_0 : \beta_4 = 0$

$H_A : \beta_4 \neq 0$ $\alpha = .05$ (two tailed)

$$t = \frac{b_4 - \beta_4}{S_{b_4}} = \frac{1.67E\text{-}05\text{-}0}{.485E\text{-}05}$$

$= 3.44$

Criterion:

For n-5 or five degrees of freedom at 90 per cent confidence, 5 per cent in each tail, $t_{.05} = 2.015$ and $t_{.025} = 2.571$, reject hypothesis if "t" is greater than 2.571 or less than -2.571.

Thus 3.44 is greater than 2.571 causing the hypothesis to be rejected. Therefore, the independent variable X_4, total labour factor input, does have a significant effect on the dependent variable, Y, Productivity.

3. Multiple Regression Data

And Calculations For The Testing Of Hypotheses

(Motor Vehicle Parts and Accessories Manufacturers)

The presentation of data and calculations for the testing of hypotheses in this sub-sector will follow the same method as in the Motor Vehicle Manufacturers sub-sector.

The Multiple Regression Model consists of five variables: a dependent variable, Y_i, and four independent variables X_1, X_2, X_3, and X_4 resulting in the following equation:

(1) $Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \epsilon_i$

Hence, the dependent variable Y_i = Productivity Index, and the four independent variables:

X_{i1} = Total Output

X_{i2} = Fuel and Electricity Factor Input

X_{i3} = Materials and Supplies Factor Input

X_{i4} = Total Labour Factor Input, and including the five regression coefficients:

a (constant) = 9.547232

b_1 = 9.52599 E - 05

b_2 =-1.7716 E - 03

b_3 =-7.61318 E - 05

b_4 =-1.9680 E - 04

Therefore, the Multiple Regression Model (1) is expressed in the following equation:

$$\hat{Y} = 9.547222 + 9.52599E\text{-}05 \cdot X_{i1} - 1.7716E\text{-}03 \cdot X_{i2} - 7.61318E\text{-}05 \cdot X_{i3} - 1.9680E\text{-}04 \cdot X_{i4}$$

A major objective of regression analysis is to make predictions of the size of a dependent variable Y_i provided independent variables are known.

A second major objective of the regression analysis is hypothesis testing. Thus, to provide sufficient data for the hypothesis testing, values of the regression coefficients, a, b_1, b_2, b_3, b_4 have been determined by the computer "Mulfit" programme [Exhibit #32.]

Since the standard deviation of regression is measured from the mean, which in itself was determined by the least-squares method, it is relatively easy to estimate the standard deviation of regression. The following expression is used to calculate the sample standard deviation of regression:

$$S_{y \cdot x} = \sqrt{\frac{\Sigma (Y-\hat{Y})^2}{n-5}} \qquad [50]$$

Wnere $S_{y \cdot x}$ is the estimate of the true standard deviation of regression, $\sigma_{y \cdot x}$, between Y and X.

To construct confidence intervals around the estimated mean, S_b must be used in testing hypothesis.

$$S_b = \frac{S_{y \cdot x}}{\sqrt{\Sigma X^2 (1-R^2)}} \qquad [50]$$

Where S_b is the estimator of a standard deviation σ_b, and R^2 is the coefficient of multiple determination. [Exhibit #32.]

Since the standard deviation of regression is measured from the mean, which in itself was determined by the least-squares method, it is relatively easy to estimate the standard deviation of regression. The following expression

is used to calculate the sample standard deviation of regression:

$$S_{y\cdot x} = \sqrt{\frac{\Sigma\,(Y-\hat{Y})^2}{n-5}} \qquad [50]$$

where $S_{y\cdot x}$ is the estimate of the true standard deviation of regression, $\sigma_{y\cdot x}$, between Y and X.

To construct confidence intervals around the estimated mean, S_b must be used in testing hypothesis.

a.) CALCULATION OF $\hat{Y}$

$\hat{Y}$ - predicted productivity was computed by the "Mulfit" programme [Exhibit #32.]

b.) REGRESSION DATA AND CALCULATION OF $\Sigma\ (Y-\hat{Y})^2$

(000 Omitted)

YEAR	X_1	X_2	X_3	X_4	$(Y-\hat{Y})$	$(Y-\hat{Y})^2$
1964	609.7	6.8	335.1	159.1	0	0
1965	725.2	8.1	385.0	181.5	.17	.029
1966	820.3	9.6	434.4	186.6	-.58	.336
1967	856.7	10.3	438.1	188.0	-1.02	1.040
1968	1,106.4	11.9	571.3	240.0	1.23	1.~~513~~
1969	1,216.3	11.2	613.3	258.6	-.58	.336
1970	1,128.8	11.5	576.8	249.1	.89	.792
1971	1,452.9	14.2	712.7	311.0	.28	.078
1972	1,633.6	16.0	800.5	341.7	.35	.123
1973	1,904.6	17.8	953.3	410.5	-.74	.548
Σ	11,454.5	117.4	5,820.5	2,526.1		4.795

c.) REGRESSION DATA

YEAR	X_1^2	X_2^2	X_3^2	X_4^2
1964	371,734.0	46.2	112,292.0	25,312.9
1965	525,915.0	65.6	148,225.0	32,942.3
1966	672,892.1	92.2	188,703.4	34,819.6
1967	733,934.9	106.1	191,931.6	35,344.0
1968	1,224,121.0	141.6	326,383.7	57,000.0
1969	1,479,385.7	125.4	376,136.9	66,874.0
1970	1,274,189.4	132.3	332,699.2	62,050.8
1971	2,110,918.4	201.6	507,941.3	96,721.0
1972	2,668,649.0	256.0	640,800.3	116,758.9
1973	3,627,501.2	316.8	908,780.9	168,510.3
Σ	11,160,643.7 $\times 10^6$	1,483.8 $\times 10^6$	3,733,894.3 $\times 10^6$	696,933.8 $\times 10^6$

d.) HYPOTHESIS TESTING

At this point, it is important to determine how far the true rate of change β is expected to deviate from the estimate of it. Thus it is proper to construct confidence limits around the estimate. In this case, the sample size of 10 is not sufficiently large to utilize the normal distribution and construct 95 per cent limits ($\pm$ 1.96 standard deviations). However, it can be assumed that the distribution of the dependent variable Y_i to be normally distributed, then the "t" distribution may be utilized. Hence, to construct a 90 per cent confidence interval utilizing the "t" distribution, the following may be used [50]:

1. Total Output Hypothesis Testing

$$S_{b_1} = \frac{S_{y \cdot x}}{\sqrt{\Sigma X_1^2 (1-R^2)}}$$

$R^2 = .949$ [Exhibit #32]

$S_{y.x} = 3.213$ "

$$S_{b_1} = \frac{S_{y \cdot x}}{\sqrt{\Sigma X_1^2 (1-.949)}}$$

$$= \frac{3.213}{\sqrt{11,160,643.7 \times 10^6 \times .051}}$$

$$= \frac{3.213}{\sqrt{569,192.8 \times 10^6}}$$

$$= .426E-05$$

$b_1 = 9.526E-05$

$b_1 - t_{.05}\, S_{b_1} < \beta_1 < b_1 + t_{.05}\, S_{b_1}$

$9.526E-05-(2.015x.426E-05 < \beta < 9.526E-05+(2.015x.426E-05)$

$9.526E-05-.858E-05 < \beta < 9.526E-05 + .858E-05$

$8.668E-05 < \beta < 10.384E-05$

$H_0 : \beta_1 = 0$

$H_A : \beta_1 \neq 0$ $\alpha = .05$ (two tailed)

$$t = \frac{b_1 - \beta_1}{S_{b_1}} = \frac{9.526E-05-0}{.426E-05}$$

$= 22.4$

Criterion:

For n-5 or five degrees of freedom, at 90 per cent confidence, 5 per cent in each tail, $t_{.05} = 2.015$ and $t_{.025} = 2.571$, reject hypothesis if "t" is greater than 2.571 or less than -2.571.

Thus 22.4 is greater than 2.571 causing the hypothesis to be rejected. Therefore, the independent variable X_1, total output, does have a significant effect on the dependent varible Y_i, Productivity.

2.) Fuel and Electricity Factor Input Hypothesis Testing

A 90 per cent confidence interval utilizing the "t" distribution can be constructed in the following manner:

$$S_{b_2} = \frac{S_{y \cdot x}}{\sqrt{\Sigma X_2^2\ (1-.949)}}$$

$$= \frac{3.213}{\sqrt{1483.9 \times 10^6 x.051}}$$

$$= \frac{3.213}{\sqrt{75.68 \times 10^6}}$$

$$= \frac{3.213}{8.70 \times 10^3}$$

$$= .369E\text{-}03$$

$$b_2 = -1.77E\text{-}03$$

$$b_2 - t_{.05} \times S_{b_2} < \beta < b_2 + t_{.05} S_{b_2}$$

$$-1.77E\text{-}03-(2.015 \times .369E\text{-}03) < \beta < -1.77E\text{-}03 + (2.015 \times .369E\text{-}03)$$

$$-1.77E\text{-}03 - .744E\text{-}03 < \beta < -1.77E\text{-}03 + .744E\text{-}03$$

$$-2.514E\text{-}03 < \beta < -1.026E\text{-}03$$

$H_0 : \beta = 0$

$H_A : \beta \neq 0$ $\qquad \alpha = .05$ (two tailed)

$$t = \frac{b_2 - \beta_2}{S_{b_2}} = \frac{-1.77E\text{-}03-0}{.369E\text{-}03}$$

$$= -4.80$$

Criterion:

For n-5 or five degrees of freedom at 90 per cent confidence, 5 per cent in each tail, $t_{.05} = 2.015$ and $t_{.025} = 2.571$, reject hypothesis if "t" is greater than 2.571 or less than -2.571.

Thus - 4.80 is less than -2.571, causing the hypothesis to be rejected. Therefore, the independent variable X_2, fuel and electricity factor input, does have a significant effect on the dependent variable Y, Productivity.

3.) Materials and Supplies Factor Input Hypothesis Testing

A 90 per cent confidence interval utilizing the "t" distribution can be constructed in the following manner:

$$S_{b_3} = \frac{S_{y\cdot x}}{\sqrt{\Sigma X_3^2 (1-.949)}}$$

$$= \frac{3.213}{\sqrt{3,733,894.3 \times 10^6 \times .051}}$$

$$= 7.36E-06$$

$$b_3 = -7.61E-05$$

$$b_3 - t_{.05} S_{b_3} < \beta_3 < b_3 + t_{.05} S_{b_3}$$

$$-7.61E-05 - (2.015 \times .736E-05) < \beta_3 < -7.61E-05 + (2.015 \times .736E-05)$$

$$-7.61E-05 - 1.483E-05 < \beta_3 < -7.61E-05 + 1.483E-05$$

$$-9.093E-05 < \beta_3 < -6.127E-05$$

H_0: $\beta_3 = 0$

H_A: $\beta_3 \neq 0$ $\qquad \alpha = .05$ (two tailed)

$$t = \frac{b_3 - \beta_3}{S_{b_3}} = \frac{-7.61E-05-0}{.736E-05}$$

$$= -10.30$$

Criterion:

For n-5 or five degrees of freedom at 90 per cent confidence, 5 per cent in each tail, $t_{.05} = 2.015$ and $t_{.025} = 2.571$, reject hypothesis if "t" is greater than 2.571 or less than -2.571.

Thus -10.3 is less than -2.571 causing the hypothesis to be rejected. Therefore, the independent variable X_3, materials and supplies factor input, does have a significant effect on the dependent variable Y, Productivity.

4.) Total Labour Factor Input Hypothesis Testing

A 90 per cent confidence interval using the "t" distribution can be constructed as follows:

$$S_{b_4} = \frac{S_{y \cdot x}}{\sqrt{\Sigma X_4^2 \ (1-.949)}}$$

$$= \frac{3.213}{\sqrt{696{,}933.8 \times 10^6 \times .051}}$$

$$= 5.39E-06$$

$$b_4 = -1.96E-04$$

$$b_4 - t_{.05} \, S_{b_4} < \beta_4 < b_4 + t_{.05} \, S_{b_4}$$

$$-1.96E-04 - (2.015 \times .054E-04) < \beta_4 < 1.96E-04 + (2.015 \times .054E-04)$$

$$-1.96E-04 - .109E-04 < \beta_4 < -1.96E-04 + .109E-04$$

$$-2.069E-04 < \beta_4 < -1.851E-04$$

$$t = \frac{b_4 - \beta_4}{S_{b_4}}$$

$$= \frac{-1.96E-04-0}{5.39E-06}$$

$$= -36.40$$

Criterion:

For n-5 or five degrees of freedom at 90 per cent confidence, 5 per cent in each tail, $t_{.05}$ = 2.015 and $t_{.025}$ = 2.571, reject hypothesis if "t" is greater than 2.571 or less than -2.571 .

Thus -36.4 is less than -2.571 causing the hypothesis to be rejected. Therefore, the independent variable X_4, total labour factor input, does have a significant effect on the dependent variable Y, Productivity.

4. Regression Coefficients and Significance of Hypotheses Testing

A regression coefficient measures the change in the dependent variable Y_i that is associated with variations in the independent variables X_{ij}. The parameters β_1, β_2, β_3 and β_4 are called partial regression coefficients because they reflect the partial effect of one independent variable when the other independent variables are included in the model and are held constant. [49]

Each of the partial regression coefficients, in both Motor Vehicle and Parts and Accessories Manufacturers sub-sectors, was subjected to a test of hypothesis to determine which, if any, of the independent variables X_{ij} are significant. In the seven cases, the independent variables X_{ij} do have significant effects on the dependent variable Y_i, and all partial regression coefficients, regardless of their sizes, do have significant effects on the dependent variables Y_i as long as they are not equal to zero. A significant non-zero slope is indicative of a relationship between the independent and the dependent variables.

The least-squares estimates of β_0 β_1, β_2, β_3, and β_4 were obtained by computing the five regression coefficients a, b_1, b_2, b_3 and b_4 which are utilized in the predicted productivity regression equations.

a.) $\hat{Y} = -17.47 + 1.58E\text{-}05X_1 + 4.52E\text{-}03X_2 - 3.51E\text{-}05X_3 + 1.67E\text{-}05X_4$

This predicted productivity regression function indicates that the mean dependent variable , $\hat{Y}$, is expected to increase by 1.58E-05 when the total factor output X_1, increases by a unit holding the other independent variables X_2, X_3 and X_4 constant regardless of at what levels they are held. The mean dependent variables, $\hat{Y}$, is expected to increase by 4.52E-03 when the fuel and electricity factor input, X_2, increases by a unit holding the other independent variables X_1, X_3 and X_4 constant. The mean predicted productivity $\hat{Y}$, is expected to decrease by 3.51E-05 when the materials and supplies factor input, X_3, increases by a unit holding the other independent variables X_1, X_2, and X_4 constant, no matter at what levels they are held. The mean predicted productivity, $\hat{Y}$, is expected to increase by 1.67E-05 when the total labour factor input, X_4, increases by a unit holding the other independent variables X_1, X_2, and X_3 constant.

The nature and significance of the relations between the four independent variables and the dependent variable, as expressed in macroeconomic terms and the change measured by their respective regression coefficients, indicate a positive productivity trend in the Motor Vehicles Manufacturers' subsector.

Regression coefficient (-3.51E-05) for the variable X_3, materials and supplies factor input, indicates a decreasing effect due to the fact that this variable was overpriced in the macroeconomic sector with upward cost pressures and, therefore, was contributing a negative influence to the productivity trend. Other two regression coefficients of factor inputs b_2 and b_4 indicate increasing effects due to controllable prices and costs of the independent variables X_2 and X_4 (energy and labour) therefore, they contribute a positive influence to the productivity growth.

b.) $\hat{Y} = 9.55 + 9.53E\text{-}05X_1 - 1.77E\text{-}03X_2 - 7.62E\text{-}05X_3 - 1.96E\text{-}04X_4$

The coefficient b_1 indicates the increase by 9.53E-05 in the mean predicted productivity $\hat{Y}$ per unit increase in the independent variable X_1, total factors output, when the other independent variables X_2, X_3 and X_4 are held constant, no matter at what levels they are held. The coefficient b_2 indicates the decrease by 1.77E-03 in the mean predicted productivity, $\hat{Y}$, per unit increase in the independent variable X_2, fuel and electricity factor input, when the other independent variables X_1, X_3 and X_4 are held constant. The coefficient b_3 indicates the decrease by 7.62E-05 in the mean predicted productivity, $\hat{Y}$, per unit increase in the independent variable X_3, materials and supplies factor input, holding the other independent variables X_1, X_2 and X_4 constant. The mean dependent variable $\hat{Y}$ is expected to decrease by 1.96E-04 when the total labour factor input increases by a unit holding the other independent variables X_1, X_2 and X_3 constant.

The Motor Vehicle Parts and Accessories Manufacturers' sub-sector indicates the nature and significance of the relations between the four independent variables and the dependent variable with the change measured by their respective regression coefficients in rather different and mixed terms.

Regression coefficients b_2, b_3 and b_4 for the independent variables X_2, X_3 and X_4 all three factor inputs, indicate decreasing effects due to the fact that this sub-sector comprises relatively larger number of individual plants which operate on the basis of less productive efficiency, lower dollar volume buying power and more upward cost and price pressures than their counterparts in the Motor Vehicle Manufacturers' sub-sector. Therefore, this sub-sector indicates a negative productivity growth in 1965 and, then, slowly increases it, never reaching the magnitude as the Motor Vehicle Manufacturers' sub-sector.

The magnitude of the effect of any given of eight independent variables on the two dependent variables in the two macroeconomic sub-sectors is very significant ($p \leq .05$).

In summary, regression coefficients a, b_1, b_2, b_3 and b_4 are significant indicators and measure of the change in the predicted productivity that is associated with variations in the independent economic factors contributing to productive efficiency in the Canadian Automotive Macroeconomic Sector.

CHAPTER VI

SUMMARY AND CONCLUSIONS

This study endeavours to take the Integrated Systems approach and Multiple Regression to analyze the growth and performance of the Canadian automotive industry since the signing and implementation of the Canada-United States Automotive Products Trade Agreement of 1965.

The Automotive Products Trade Agreement of 1965 between Canada and the United States has helped the Canadian automotive industry to become more efficient and productive. It has helped Canadian automotive manufacturers be able to compete in the North American market, and make its significant contribution to the Canadian economy.

In this study, there is definite correlation between total labour productivity and total factors productivity, and both tend to increase with the increased volume of output. Total factors productivity tends to be higher in the capital-intensive sub-sector of the automotive industry. The influence of productivity growth on costs and prices explains its critical importance in the fight against inflation and provides improved positions in a competitive market.

Productivity movements are affected by a large number of factors, such as the quality and effort of labour and management, the state and application of technology, the availability of capital, economies of scale, materials and supplies, fuel and electricity, as well as market fluctuations.

Productivity trend analyses indicate that the Canadian automotive industry had the fastest increase in productivity in the first three years of the Agreement's implementation, particularly in the Motor Vehicle sub-sector. Parts and Access-, ories sub-sector did not fair well in the first three years following the implementation of the Agreement. However, the average improvement in the productivity rate ranged from 12.90 per cent per year in the Motor Vehicle Manufacturers sub-sector to 4.54 per cent per year in the Parts and Accessories Manufacturers sub-sector.

When considering total industrial manufacturing spectrum, the automotive manufacturing sector has the second fastest rate of production increase and the highest rate of increase in the productivity growth in Canada. [71]

Therefore, productivity trend analyses illustrate by means of productivity indexes and graphs that the Agreement, despite its shortcomings, has helped the Canadian automotive Macroeconomic sector and the economy to improve in productive efficiency and productivity growth.

Suggestion For Future Research

1. It is suggested to research other macro-economic sectors or industrial groups with a view of providing productivity trend analyses by means of total factors productivity concept and the integrated systems method.

2. Productivity centers or productivity institutes are being established in almost every industrialized nation for the purpose of accumulating and disseminating meaningful and useful information to all those concerned with and about the productivity growth and its measures.

It is suggested that a research programme be undertaken to establish productivity concept as the productivity science.

The productivity science may encompass other disciplines to serve common and meaningful purpose for the benefit of the national economy and manufacturing industry sector in particular. Other disciplines and/or techniques may be included as main body of the productivity science:

1. Operations research
2. Management science
3. Ergonomics
4. Net work analysis
5. Organization analysis and methods
6. Work study
7. Value analysis
8. Cost and financial analysis
9. Systems analysis
10. Macro-economic productivity forecasting models (computer)
11. Others to serve management function of productivity improvement.

TABLE #1

PRINCIPAL STATISTICS, 1964 - 1973

(MOTOR VEHICLE MANUFACTURERS)

(CURRENT DOLLARS)

Year	Establishments	Manufacturing Activities: Prod. and Related Workers: Number Empl.	Manufacturing Activities: Prod. and Related Workers: Man-Hours Paid	Manufacturing Activities: Prod. and Related Workers: Wages and Salaries	Manufacturing Activities: Cost of Fuel and Electricity Purchased	Manufacturing Activities: Cost of Materials and Supplies	Manufacturing Activities: Value of Shipments of Goods of Own Manufacture	Manufacturing Activities: Value Added	Total Activities: Number of Employees	Total Activities: Wages and Salaries	Total Activities: Value Added
			'000 Omitted	$'000 Omitted						$'000 Omitted	
1964	18	24,860	55,921	153,790	6,720	1,206,433	1,678,817	491,775	36,026	234,551	548,077
1965	20	30,014	69,138	207,176	8,126	1,505,949	2,120,302	631,390	42,432	302,578	732,775
1966	19	29,746	65,953	203,552	8,993	1,566,246	2,165,769	613,021	42,507	308,952	717,023
1967	20	28,333	63,782	203,308	10,053	1,713,501	2,479,259	760,934	40,861	308,055	943,124
1968	21	26,965	62,014	231,001	11,472	2,195,259	3,002,279	827,182	39,113	349,509	1,053,754
1969	22	29,278	65,381	253,808	12,770	2,596,030	3,554,131	934,068	41,916	383,943	1,159,938
1970	22	25,303	54,646	229,311	12,129	2,300,124	2,962,528	664,423	38,145	371,804	869,195
1971	22	29,480	62,631	279,937	14,316	2,817,805	3,681,719	850,317	42,334	440,925	1,180,571
1972	22	30,580	69,093	332,725	15,753	3,124,163	4,033,647	906,774	44,042	511,456	1,362,071
1973	21	32,770	74,709	390,680	16,673	3,701,864	4,715,829	1,033,835	46,831	591,800	1,551,760

Source: Statistics Canada Cat. #42-209

TABLE #2

PRINCIPAL STATISTICS, 1964 - 1973

(MOTOR VEHICLE PARTS AND ACCESSORIES MANUFACTURERS)

(CURRENT DOLLARS)

Year	Establishments	Manufacturing Activities							Total Activities		
		Prod. and Related Workers			Cost of Fuel and Electricity Purchased	Cost of Materials and Supplies	Value of Shipments of Goods of Own Manufacture	Value Added	Number of Employees	Wages and Salaries	Value Added
		Number Empl.	Man-Hours Paid	Wages and Salaries							
			'000 Omitted	$'000 Omitted						$'000 Omitted	
1964	154	23,845	52,262	127,727	7,148	354,258	627,966	281,677	29,442	168,183	285,814
1965	160	25,748	57,268	149,217	8,796	418,779	755,608	325,641	31,982	197,403	333,367
1966	174	27,928	59,730	155,879	10,688	482,156	860,500	377,273	34,759	207,169	384,521
1967	178	27,993	59,547	161,614	11,772	501,135	912,422	402,322	34,858	215,329	410,255
1968	179	31,720	69,684	212,769	13,863	667,993	1,193,805	512,418	39,454	280,666	521,489
1969	178	33,815	73,207	240,716	13,616	745,699	1,340,376	608,032	41,541	314,394	617,963
1970	182	30,647	64,231	225,617	14,306	716,932	1,272,154	541,079	38,866	309,574	549,253
1971	203	35,753	77,246	301,885	17,912	898,438	1,660,665	743,802	43,810	392,003	753,828
1972	211	37,921	82,249	342,238	20,530	1,028,599	1,903,161	866,628	46,189	438,992	876,042
1973	229	44,135	96,232	434,386	23,772	1,272,132	2,304,562	1,031,855	52,831	547,836	1,043,613

Source: Statistics Canada Cat. #42-210

TABLE #3

MOTOR VEHICLE FACTORY SHIPMENTS AND WHOLESALE VALUE, 1964 - 1973

(CURRENT DOLLARS)

Year	Passenger Cars		Motor Trucks and Buses		Total	
	Factory Shipments	Wholesale Value	Factory Shipments	Wholesale Value	Factory Shipments	Wholesale Value
		$'000 Omitted		$'000 Omitted		$'000 Omitted
1964	558,210	1,233,762	112,096	296,354	670,306	1,530,116
1965	705,620	1,561,154	138,225	358,814	843,845	1,919,968
1966	683,374	1,481,732	187,070	463,973	870,444	1,945,705
1967	711,883	1,644,635	211,911	537,654	923,794	2,182,289
1968	885,191	2,102,881	260,141	656,691	1,145,332	2,759,572
1969	1,032,571	2,474,040	301,261	787,791	1,333,832	3,261,831
1970	922,659	2,125,493	236,199	656,751	1,158,858	2,782,244
1971	1,083,351	2,810,759	263,967	786,613	1,347,318	3,597,372
1972	1,135,872	2,476,988	293,584	956,081	1,429,456	3,933,069
1973	1,220,133	3,358,383	331,678	1,218,345	1,551,811	4,576,728

Source: Statistics Canada Cat. #42-209

TABLE #4

EMPLOYMENT AND PAYROLL, 1964 - 1973

(MOTOR VEHICLE MANUFACTURERS)

(CURRENT DOLLARS)

Year	Number of Employees								Salaries and Wages			
	Production and Related Workers		Administration and Office		Sales and Distribution		Total		Production and Related Workers	Administration and Office	Sales and Distribution	Total
	Male	Female	Male	Female	Male	Female	Male	Female				
									$'000 Omitted			
1964	24,455	476	6,104	1,515	2,847	629	33,406	2,620	153,790	57,093	23,288	234,551
1965	29,525	588	6,777	1,666	3,214	662	39,516	2,916	207,176	66,906	27,918	302,518
1966	29,470	411	6,960	1,673	3,314	679	39,744	2,763	203,552	73,766	30,897	308,952
1967	28,094	366	6,710	1,527	3,489	675	38,293	2,568	203,308	70,796	33,165	308,055
1968	26,901	203	6,386	1,405	3,517	700	36,804	2,308	231,001	78,973	38,605	349,489
1969	29,041	237	6,708	1,407	3,820	703	39,569	2,347	253,808	86,762	43,373	383,943
1970	25,160	143	6,754	1,377	3,993	718	35,907	2,238	229,311	95,588	46,906	371,804
1971	29,238	242	6,661	1,179	4,316	698	40,215	2,119	279,937	105,878	55,109	440,923
1972	30,322	258	6,926	1,365	4,472	699	41,720	2,322	332,725	116,919	61,811	511,458
1973	32,462	308	7,264	1,469	4,624	704	44,350	2,481	390,680	133,448	67,672	591,800

Source: Statistics Canada Cat. #42-209

TABLE #5

EMPLOYMENT AND PAYROLL, 1964 - 1973

(MOTOR VEHICLE PARTS AND ACCESSORIES MANUFACTURERS)

(CURRENT DOLLARS)

Year	Number of Employees								Salaries and Wages			
	Production and Related Workers		Administration and Office		Sales and Distribution		Total		Production and Related Workers	Administration and Office	Sales and Distribution	Total
	Male	Female	Male	Female	Male	Female	Male	Female				
									$'000 Omitted			
1964	20,349	3,548	3,859	1,077	505	104	24,713	4,729	127,989	36,241	3,954	168,183
1965	21786	4,029	4,308	1,221	527	111	26,621	5,361	149,633	43,576	4,295	197,403
1966	23,226	4,833	4,666	1,351	570	113	28,462	6,297	156,604	45,681	4,884	207,169
1967	23,367	4,745	4,690	1,329	615	112	28,672	6,186	162,242	47,583	5,505	215,329
1968	25,985	5,814	5,375	1,480	673	127	32,033	7,421	213,341	60,394	6,930	280,666
1969	27,878	6,092	5,252	1,458	712	149	33,842	7,699	241,965	64,701	7,729	314,394
1970	25,485	5,412	5,675	1,459	697	138	31,857	7,009	228,349	73,066	8,160	309,574
1971	29,555	6,285	5,701	1,494	662	113	35,918	7,892	302,621	81,946	7,436	392,003
1972	30,905	7,064	5,948	1,476	672	124	37,525	8,664	342,725	87,946	8,322	438,992
1973	35,530	8,609	6,128	1,549	828	187	42,486	10,345	436,425	102,562	10,850	547,836

Source: Statistics Canada Cat. #42-210

TABLE #6

CORPORATION FINANCIAL STATISTICS, 1965-1973

(MOTOR VEHICLE AND PARTS AND ACCESSORIES MANUFACTURERS)

CURRENT DOLLARS ($000,000 OMITTED)

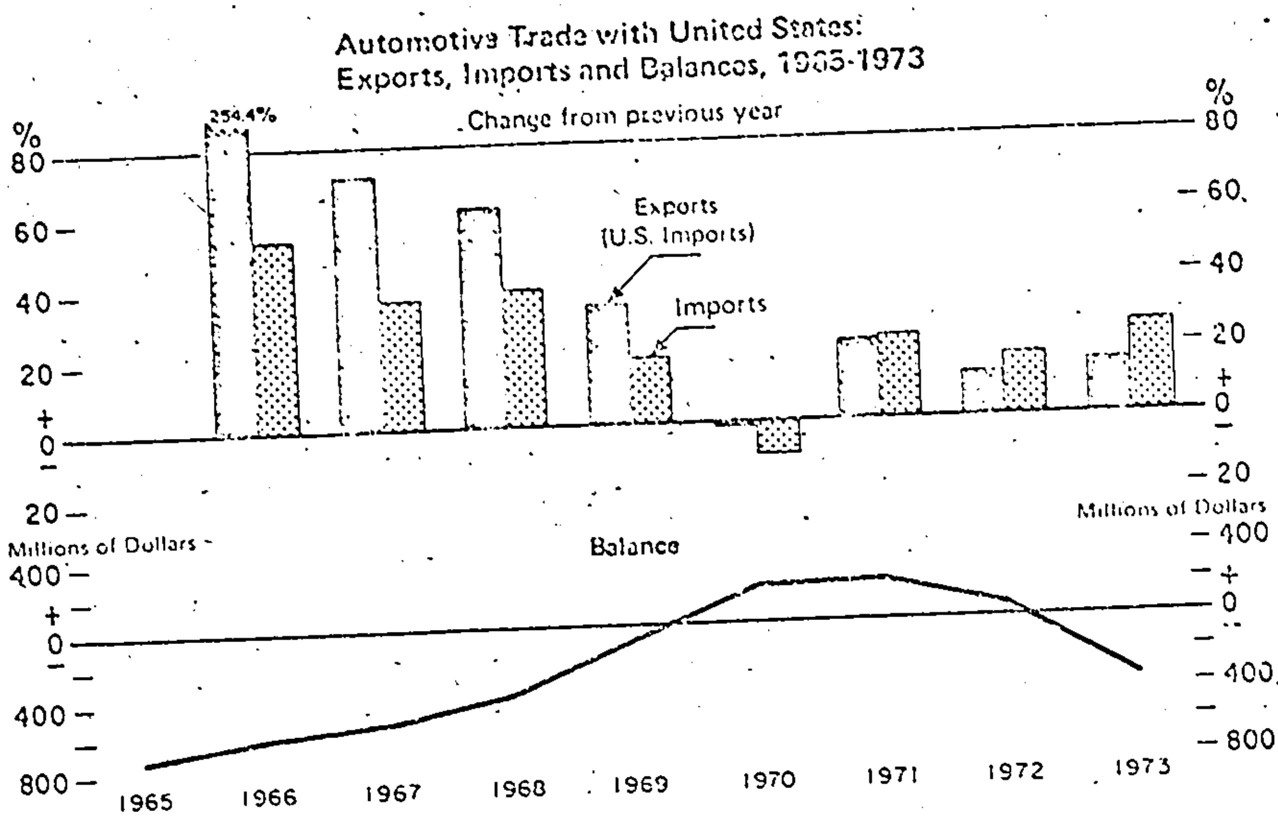
	1965	1966	1967	1968	1969	1970	1971	1972	1973
No. of Corp.	212	196	191	206	215	215	189	227	234
Total Assets	1,408.9	1,733.1	1,973.0	2,125.7	2,272.6	2,296.1	2,430.8	3,343.2	3,906.3
Total Liabilities	704.3	1,037.3	1,183.7	1,212.6	1,072.3	1,076.3	1,091.8	1.547.2	1,885.8
Total Equity	704.6	695.9	790.3	913.1	1,200.3	1,219.8	1,339.0	1,796.0	2,020.5
Total Liab.&Equity.	1,408.9	1,733.2	1,979.0	2,125.7	2,272.6	2.296.1	2.430.8	3,343.2	3,906.3
Total Income	3,109.3	3,526.3	4,186.4	5,107.4	6,369.7	5,625.0	7,141.0	10,027.1	11,389.6
Total Deductions	2,993.0	3,459.4	4,081.3	4,811.7	6,011.6	5,464.3	6,740.3	9.387.1	10,767.8
Net Profit	116.3	66.9	105.0	169.7	195.4	90.8	219.5	380.8	368.2
RETAINED EARNINGS:									
Opening Balance	600.9	646.0	607.6	674.1	819.6	1,024.3	1,048.7	1,386.5	1,587.8
Net Profit	116.3	66.9	105.0	169.7	195.4	90.8	219.5	380.8	368.2
Dividends	71.4-	110.1-	24.8-	25.3-	21.5-	33.2-	90.2-	159.5-	157.8-
Other Credits	1.8	6.3	3.9-	1.4	30.8	42.7-	4.9	1.1-	94.5-
Closing Balance	649.2	609.2	685.4	819.6	1,024.3	1,039.2	1,166.5	1,587.8	1,784.7

TABLE #7

PRODUCTION DATA-DEFLATORS (1961 = 100.00)

Year	Motor Vehicle Manufacturers		Motor Vehicle Parts and Accessories Manufacturers	
	Output	Input	Output	Input
1961	100.00	100.00	100.00	100.00
1962	101.20	103.80	100.70	102.80
1963	101.60	105.04	103.20	103.71
1964	101.30	107.17	103.00	105.73
1965	100.70	109.34	104.20	108.78
1966	99.90	111.60	104.90	111.00
1967	99.90	115.03	106.50	114.52
1968	101.80	118.35	107.90	116.93
1969	102.60	122.53	110.20	121.59
1970	103.90	124.00	112.70	124.30
1971	106.50	127.10	114.30	126.06
1972	108.70	129.73	116.50	128.49
1973	107.90	128.78	121.00	133.45

Source: Statistics Canada Cat. #62-002 and #62-528



Source: Facts and Figures of the Automotive Industry

APPENDIX "A"

AGREEMENT CONCERNING AUTOMOTIVE PRODUCTS BETWEEN THE GOVERNMENT OF CANADA AND THE GOVERNMENT OF THE UNITED STATES OF AMERICA [20]

The Government of Canada and the Government of the United States of America,

Determined to strengthen the economic relations between their two countries;

Recognizing that this can best be achieved through the stimulation of economic growth and through the expansion of markets available to producers in both countries within the framework of the established policy of both countries of promoting multilateral trade;

Recognizing that an expansion of trade can best be achieved through the reduction or elimination of tariff and all other barriers to trade operating to impede or distort the full and efficient development of each country's trade and industrial potential;

Recognizing the important place that the automotive industry occupies in the industrial economy of the two countries and the interests of industry, labour and consumers in sustaining high levels of efficient production and continued growth in the automotive industry;

Agree as follows:

Article I

The Governments of Canada and the United States, pursuant to the above principles, shall seek the early achievement of the following objectives:

(a) The creation of a broader market for automotive products within the full benefits of specialization and large-scale production can be achieved;

(b) The liberalization of United States and Canadian automotive trade in respect of tariff barriers and other factors tending to impede it, with a view to enabling the industries of both countries to participate on a fair and equitable basis in the expanding total market of the two countries;

(c) The development of conditions in which market forces may operate effectively to obtain the most economic pattern of investment, production and trade.

It shall be the policy of each Government to avoid actions which would frustrate the achievement of these objectives.

Article II

(a) The Government of Canada, not later than the entry into force of the legislation contemplated in paragraph (b) of this Article, shall accord duty-free treatment to imports of the products of the United States described in Annex A.

(b) The Government of the United States, during the session of the United States Congress commencing on January 4, 1965, shall seek enactment of legislation authorizing duty-free treatment of imports of the products of Canada described in Annex B. In seeking such legislation, the Government of the United States shall also seek authority permitting the implementation of such duty-free treatment retroactively to the earliest date administratively possible following the date upon which the Government of Canada has accorded duty-free treatment. Promptly after the entry into force of such legislation, the Government of the United States shall accord duty-free treatment to the products of Canada described in Annex B.

Article III

The commitments made by the two Governments in this Agreement shall not preclude action by either Government consistent with its obligations under Part II of the General Agreement on Tariffs and Trade.

Article IV

(a) At any time, at the request of either Government, the two Governments shall consult with respect to any matter relating to this Agreement.

(b) Without limiting the foregoing, the two Governments shall, at the request of either Government, consult with respect to any problems which may arise concerning automotive producers in the United States which do not at present have facilities in Canada for the manufacture of motor vehicles, and with respect to the implications for the operation of this Agreement of new automotive producers becoming established in Canada.

(c) No later than January 1, 1968, the two Governments shall jointly undertake a comprehensive review of the progress made towards achieving the objectives set forth in Article I. During this review the Government shall consider such further steps as may be necessary or desirable for the full achievement of these objectives.

Article V

Access to the Canadian and United States markets provided for under this Agreement may by agreement be accorded on similar terms to other countries.

Article VI

This Agreement shall enter into force provisionally on the date of signature and definitively on the date upon which notes are exchanged between the two Governments giving notice that appropriate action in their respective legislatures has been completed.

Article VII

This Agreement shall be of unlimited duration. Each Government shall, however, have the right to terminate this Agreement twelve months from the date on which that Government gives written notice to the other Government of its intention to terminate the Agreement.

DONE in duplicate at Johnson City, Texas, this 16th day of January, 1965, in English and in French, the two texts being equally authentic.

IN WITNESS WHEREOF the representatives of the two Governments have signed this Agreement.

For the Government of Canada:

Lester B. Pearson

Paul Martin

....

For the Government of the U.S.A.

Lyndon B. Johnson

ANNEX A

1. (1) Automobiles, when imported by a manufacturer of automobiles.

(2) All parts, and accessories and parts thereof, except tires and tubes, when imported for use as original equipment in automobiles to be produced in Canada by a manufacturer of automobiles.

(3) Buses, when imported by a manufacturer of buses.

(4) All parts, and accessories and parts thereof, except tires and tubes, when imported for use as original equipment in buses to be produced in Canada by a manufacturer of buses.

(5) Specified commercial vehicles, when imported by a manufacturer of specified commercial vehicles.

(6) All parts, and accessories and parts thereof, except tires and tubes and any machines or other articles required under Canadian tariff item 438a to be valued separately under the tariff items regularly applicable thereto, when imported for use as original equipment in specified commercial vehicles to be produced in Canada by a manufacturer of specified commercial vehicles.

2. (1) "Automobile" means a four-wheeled passenger automobile having a seating capacity for not more than ten persons;

(2) "Base Year" means the period of twelve months commencing on the 1st day of August, 1963, and ending on the 31st day of July, 1964;

(3) "Bus" means a passenger motor vehicle having a seating capacity for more than 10 persons, or a chassis therefor, but does not include any following vehicle or chassis therefor, namely an electric trackless trolley bus, amphibious vehicle, tracked or half-tracked vehicle or motor vehicle designed primarily for off-highway use;

(4) "Canadian value added" has the meaning assigned by regulations made under Section 273 of the Canadian Customs Act;

(5) "Manufacturer" of vehicles of any following class, namely automobiles, buses, or specified commercial vehicles, means, in relation to any importation of goods in respect of which the description is relevant, a manufacturer that

(i) produced vehicles of that class in Canada in each of the four consecutive three months' periods in the base year, and

(ii) produced vehicles of that class in Canada in the period of twelve months ending on the 31st day of July in which the importation is made,

(A) the ratio of the net sales value of which to the net sales value of all vehicles of that class sold for consumption in Canada by the manufacturer in that period is equal to or higher than the ratio of the net sales value of all vehicles of that class produced in Canada by the manufacturer in the base year to the net sales value of all vehicles of that class sold for consumption in Canada by the manufacturer in the base year, and is not in any case lower than seventy-five to one hundred; and

(B) the Canadian value added of which is equal to or greater than the Canadian value added of all vehicles of that class produced in Canada by the manufacturer in the base year;

(6). "Net sales value" has the meaning assigned by regulations made under Section 273 of the Canadian Customs Act; and

(7) "Specified commercial vehicle" means a motor truck, motor truck chassis, ambulances or chassis therefor, or hearse or chassis therefor, but does not include: (a) any following vehicle or chassis designed primarily therefor, namely a bus, electric trackless trolley bus, amphibious vehicle, tracked or half-tracked vehicle, golf or invalid cart, straddle carrier, motor vehicle designed primarily for off-highway use, or motor vehicle specially constructed and equipped to perform special services or functions, such as, but not limited to, fire engine, mobile crane, wrecker, concrete mixer or mobile clinic; or (b) any machine or other article required under Canadian tariff Item 438a to be valued separately under the tariff item regularly applicable thereto.

The Government of Canada may designate a manufacturer not falling within the categories set out above as being entitled to the benefit of duty-free treatment in respect of the goods described in this Annex.

ANNEX B

(1) Motor vehicles for the transport of persons or articles as provided for in items 692.05 and 692.10 of the Tariff Schedules of the United States and chassis therefor, but not including electric trolley buses, three-wheeled vehicles, or trailers accompanying truck tractors, or chassis therefor.

(2) Fabricated components, not including trailers, tires, or tubes for tires, for use as original equipment in the manufacture of motor vehicles of the kinds described in paragraph (1) above.

(3) Articles of the kinds described in paragraphs (1) and (2) above include such articles whether finished or unfinished but do not include any article produced with the use of materials imported into Canada which are products of any foreign country (except materials produced within the customs territory of the United States), if the aggregate value of such imported materials when landed at the Canadian port of entry, exclusive of any landing cost and Canadian duty, was

(a) with regard to articles of the kinds described in paragraph (1), not including chassis, more than 60 per cent until January 1, 1968, and thereafter more than 50 per cent, of the appraised customs value of the article imported into the customs territory of the United States; and

(b) with regard to chassis of the kinds described in paragraph (1), and articles of the kinds described in paragraph (2), more than 50 per cent of the appraised customs value of the article imported into the customs territory of the United States.

APPENDIX "B"

HISTORICAL HIGHLIGHTS OF THE CANADIAN AUTOMOTIVE INDUSTRY

1904 Ford Motor Company of Canada, Limited, established at Windsor. 117 motor vehicles produced in the first year.

1907 McLaughlin Motor Car Company established at Oshawa.

1909 E.M.F. of Canada, Limited, began operations at Walkerville, Ontario (later Studebaker of Canada, Limited).

1911 Self-starters introduced; International Harvester established at Chatham -- assumed assets of Chatham Wagon Works (first truck produced in 1920).

1912 All-steel bodies introduced but most remained wood framed.

1914 The assembly line technique developed.

1915 Chevrolet of Canada established at Oshawa.

1917 93,810 automobiles produced -- first calendar year for which statistical records are available.

1918 McLaughlin and Chevrolet of Canada became General Motors of Canada, Limited.

1920 International Harvester Company of Canada, Limited, began building model S motor trucks.

1922 Balloon tires introduced. Automobiles subject to special excise taxes of 5% or 10% depending upon the value of the vehicle.

1923 Four-sheel brakes appeared on popular makes.

1924 Automotive products rank as Canada's fourth largest export item.

1925 Chrysler Corporation of Canada, Limited, was established at Windsor -- assumed Canadian assets of Maxwell-Chalmers.

1926 Safety glass offered. "Canadian Content" concept introduced. The 35% duty on automobiles, inherited from the carriage building industry, reduced to 20% on vehicles valued at not more than $1200.00 and 27½% on vehicles valued at over $1200.00 with lower British preferential rates. Total mileage of surfaced highway and rural roads exceeded 50,000 miles.

1928 Synchronized transmission introduced. One million vehicles registered.

1929 Stock Market crash ushered in the Depression.

1930 One million driver licenses issued.

1932 Depression reached lowest point -- only 61,000 vehicles produced. Provision made for duty-free entry for all motor vehicles imported from the United Kingdom.

1935 All-steel body in general use.

1936 United States accorded intermediate tariff rates of 17½% on motor vehicles. Total mileage of surfaced highway and rural roads exceeded 100,000 miles.

1940 Military vehicle production increased. Special excise taxes increased to 20% to 90% depending upon the value of the vehicle. Two million driver licenses issued.

1942 The Canadian automobile industry discontinued production of motor vehicles for civilian use.

1944 500,000th war vehicle produced.

1945 Civilian car production started again; a flat rate of 10% excise tax imposed.

1946 The Nash Motor Company, predecessor of American Motors (Canada) Limited, began producing automobiles in Toronto.

1947 Studebaker moved their operations to Hamilton, Ontario. To conserve foreign exchange the special excise tax increased from the 10% flat rate to 25% on vehicles valued at $1,200.00 and less, 50% on those valued from $1,200.00 to $2,000.00 and 75% on those valued at more than $2,000.00.

1948 International Harvester opened plant at Chatham. Special excise tax revised to the former 10% flat rate. Total mileage of surfaced highway and rural roads exceeded 150,000 miles. Two million vehicles registered.

1950 Excise tax increased from 10% to 15%. Three million driver licenses issued.

1951 Excise tax increased from 15% to 25%.

1952 Ford moved its assembly operations to Oakville. Excise tax reduced from 25% to 15%. Three million vehicles registered. Four million driver licenses issued.

1954 Tubeless tires standard equipment on automobiles.

1955 Excise tax reduced from 15% to 10%. Total mileage of surfaced highway and rural roads exceeded 200,000 miles.

1956 Four million vehicles registered.

1957 Excise tax reduced from 10% to 7½%. Five million driver licenses issued.

1959 Compact cars introduced. Five million vehicles registered. Total mileage of surfaced highway and rural roads exceeded 250,000 miles. First Kaiser jeep made in Canada.

1960 Royal Commissions appointed to study Canadian Automotive industry. Six million driver licenses issued.

1961 American Motors (Canada) Limited established plant in Brampton. Report of the Royal Commission on the Automotive Industry published. Excise tax of 7½% removed. Ten millionth vehicle produced in Canada.

1962 10% import surcharge placed upon all imported motor vehicles as of June 25th. Duty Remission Programme introduced November 1st.

1963 10% import surcharge removed from all imported motor vehicles as of March 31st. General Motors opened Canada's first automatic transmission plant at Windsor. Volvo (Canada) Ltd. began production of Volvo "Canadian" cars at Dartmouth, Nova Scotia, on June 12th. Studebaker Corp. announced transfer of auto products to Studebaker of Canada Ltd. December 9th. Duty Remission Programme expanded -- The Drury Plan -- effective November 1st. Six million vehicles registered. Total mileage of roads and streets exceeded 344,000 miles.

1964 Seven million driver licenses issued.

1965 Canada-United States Automotive Products Trade Agreement signed January 16th, 1965. 12 millionth vehicle produced in Canada. La Société de Montage Automobile Inc. (SOMA) commenced assembly of Renault passenger cars at St. Bruno, Quebec in October.

1966 Studebaker of Canada, Limited, discontinued North American production of passenger cars. Seven million vehicles registered.

1967 White Motor Company complete Kelowna plant for production of the Western Star. Remaining 6% federal sales tax removed from production machinery June 1st. Federal sales tax on manufacturers' sales price increased to 12% from 11%. Volvo moved assembly plant from Dartmouth to Halifax. Ford Motor Company of Canada, Limited, St. Thomas passenger car assembly plant opened in December. Automotive exports exceed $1 billion. Eight million driver licenses issued.

1968 CMI announced commencement of production of Japanese cars at Point Edward, Nova Scotia, in January. Over 1,000,000 vehicles produced during year.

1969 Canadian most favoured nation tariff on motor vehicles reduced from 16½% to 15% effective June 4th, 1969. Kaiser Jeep of Canada Limited discontinued Canadian assembly of Kaiser Jeeps on July 25th. Eight million vehicles registered. 16 millionth vehicle produced in Canada.

1970 Production totalled 940,389 passenger cars and 253,183 motor trucks. Average monthly employment was 54,793 with a payroll of $46,162,202. Two-door hardtops dominated passenger car body styling with 38% of production.

1971 Estimated vehicle miles travelled in Canada over 80,000,000,000. Total motor vehicle registration reached 9,022,136.

1972 Exports of Canadian automotive products to the United States increased 16.4% to $5,300,000,000. This was over one-fourth higher than the growth recorded in the previous year. Imports, on the other hand, climbed 26.3% to $5.656 million, a pick-up of over one-half from the growth in 1972.

1973. A vigorous rise in imports shifted the trade position in automotive products with the United States in 1973. The trade balance turned from a surplus of $75 million in 1972 to a deficit of $356 million in 1973, the first deficit since 1969.

Source: Facts and Figures of the Automotive Industry

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